ASKINS

Modern Steel Frame
Building Construction

Civil Engineering
B. S.
1904

UNIVERSITY
OF
ILL. LIBRARY

UNIVERSITY OF ILLINOIS
LIBRARY

BOOK | CLASS | VOLUME
1904 | As4 |

767/102 U of I.

MODERN STEEL FRAME BUILDING CONSTRUCTION

BY

ADOLPHUS EDWARD ASKINS

THESIS FOR DEGREE OF BACHELOR OF SCIENCE IN CIVIL ENGINEERING

COLLEGE OF ENGINEERING
UNIVERSITY OF ILLINOIS

PRESENTED JUNE 1904

UNIVERSITY OF ILLINOIS

May 27, 1904 190

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

ADOLPHUS EDWARD ASKINS

ENTITLED MODERN STEEL FRAME BUILDING CONSTRUCTION

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF Bachelor of Science in Civil Engineering

Ira O. Baker

HEAD OF DEPARTMENT OF Civil Engineering

66186

Digitized by the Internet Archive
in 2013

http://archive.org/details/modernsteelframe00aski

1904
As4

Preface

The object of the writer is to present some of the more important details of steel-frame building construction rather than to attempt the complete design of any one building. Considerable data for this thesis were collected by the writer during the summer of 1903, in an office devoted almost exclusively to this form of construction. The method described herein will correspond very closely with the practice of that office.

UIUC

Introduction.

The work of designing a steel-frame building should proceed somewhat as follows:

1. Arrangement of columns.
2. Arrangement of beams.
3. Calculation of column loads.
4. Dimensioning of foundations.
5. Design of spandrel sections.
6. Dimensioning of floor beams.
7. Dimensioning of columns.
8. Wind bracing.
9. Details of construction.
10. Estimate of the weight of the metal.

The drawings are usually made at the expense of the contractor, subject to the approval of the architect and consulting engineer.

1. ARRANGEMENT OF COLUMNS.- The positions of the columns depend upon the plan and character of the building, the arrangement of the rooms, the elevators, the staircases, etc., regardless oftentimes of constructional advantages and disadvantages. Very few set rules will apply to every case, for so few conditions are alike. A general scheme of the floor beam arrangement is to be borne in mind while arranging the columns. The wind bracing also is to be taken into consideration, for often the columns can be made a part of the bracing system thereby adding to the strength of the structure and also greatly reducing the cost of the wind bracing.

The question of interior appearance and often the economical arrangement of the rooms must also be kept well in mind while arranging the columns. Experience and a complete grasp of the problem at hand are the essentials for the most economical arrangement of the columns.

2. ARRANGEMENT OF BEAMS.— As soon as the positions of the columns are determined, the approximate positions of the girders and the more important beams must be fixed. In as much as the girders carry the floor loads to the columns, the sizes may be determined. The sizes of the smaller beams of the floor system are generally determined after the girders are dimensioned. These smaller beams are dimensioned to carry their particular loading.

The girders usually consist of plates and angles riveted together, constituting what is called a "built section," but a girder may be simply a rolled I beam. A "girder beam" means a rolled I beam used as a girder. A "double girder" consists of two rolled I beams. The smaller beams should be arranged so as to carry their loads to the columns as directly as possible, and to do this they must frame directly into the girders. In most large buildings several of the floor beams

are the same. Usually a typical floor plan is drawn giving the dimensions for all floors that are alike, then the drawings of the floors which differ from the typical plan are made as simple as possible, giving only the dimensions which differ from the typical floor plan. The positions of the columns are indicated upon the drawings by sketches like the section of the column, while a heavy line represents the positions of the girders and floor beams. Fig. 1, and 2, page 4, shows this method of representing columns and floor beams. Fig. 1. shows the relative positions of the columns in a section of a floor plan. The sketches of the columns are made similar to their cross-sections. Thus, the sketches in Fig. 1. are similar to Fig. 3. which shows the construction of the columns. They are composed of two channels, placed back to back, with plates riveted

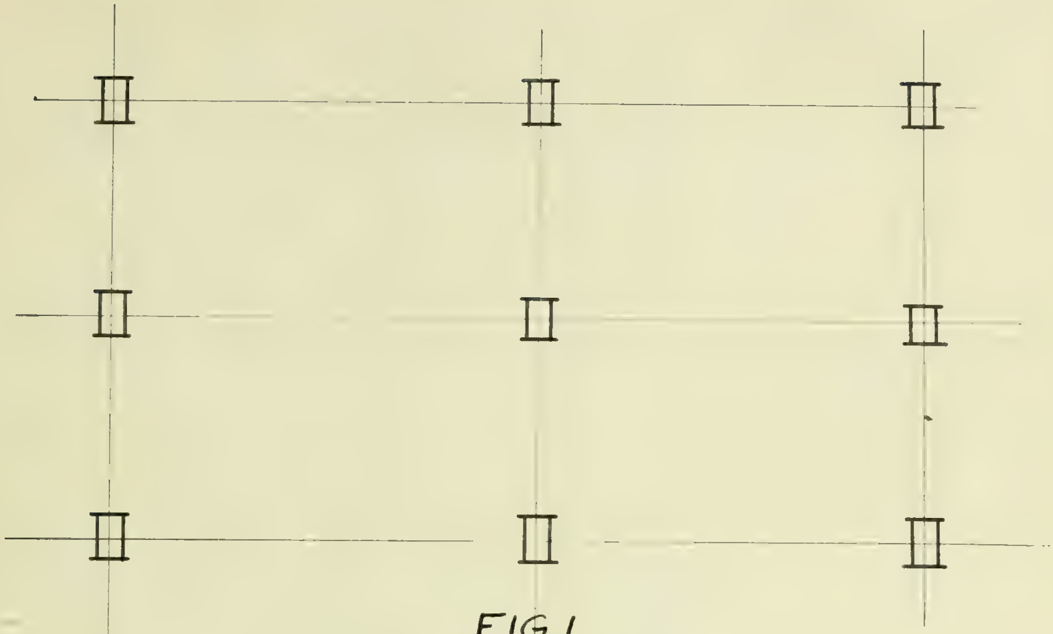


FIG. 1.

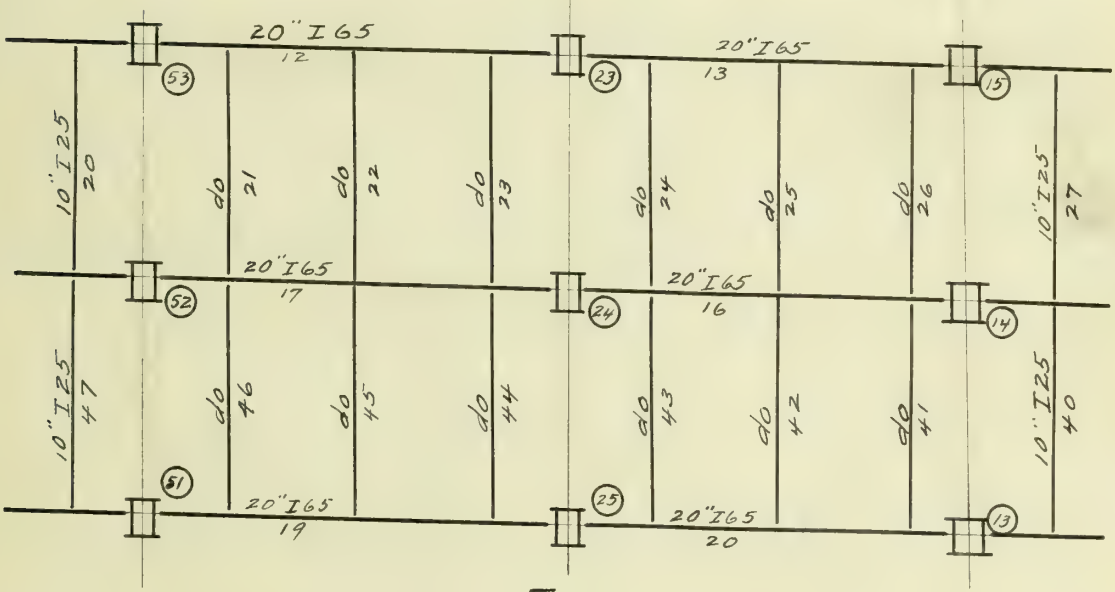


FIG. 2.

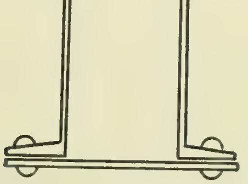


FIG. 3.

on each side.

Fig. 2. shows the same floor plan after the girders and beams have been located. The number of the column is usually placed in a small circle as shown, while the number and size of the girders and beams are written under or above the corresponding beam or girder respectively and parallel with it. The numbers aid in referring to the details, and also in the erection, for a number is marked upon each piece corresponding to the detail number. These numbers are painted upon the several pieces at the mill. Drawings are made of all the floors, showing the sizes of all the beams and girders, the numbers of all the beams, girders, and columns, dimension lines and everything necessary for a complete understanding of all the constructional features.

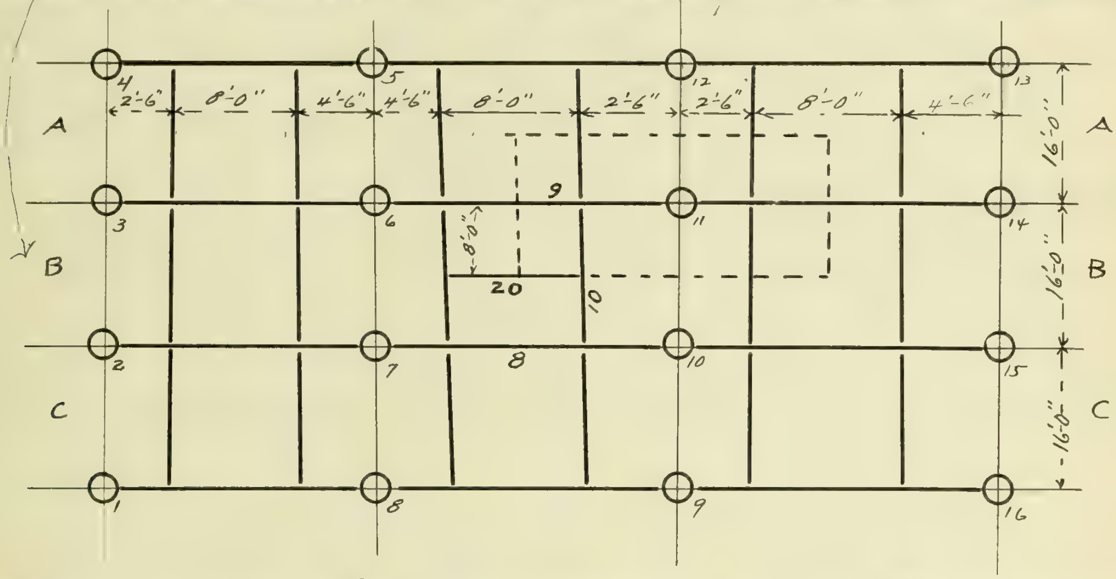
3. CALCULATION OF COLUMN LOADS.-

The column loads are divided into two classes, dead loads and live loads. The load produced by the actual weight of the building itself constitutes the dead load. The weight of the movable stock of goods, furniture, and people constitute the live load. If vaults, safes, machinery, etc., are permanently fixed, they are rated as dead load; if not fixed they are rated as live load.

The weight of the floor varies for the different form of construction, that is, with the kind of material used. If the assumed dead load is stated in the specifications, the engineer is saved considerable trouble in figuring weights; but if the assumed dead load is not stated, the weights of the different materials must be determined as nearly as possible. The weight of the floor is in-

pounds per square foot of floor area. The floor area supported by each column is determined from the floor plans, and this amount multiplied by the weight per square foot of floor gives the desired load for the column. There are several ways of determining the area carried by each column; but unless the problem is a very complicated one, the floor is divided into rectangles cornering at the columns. Each rectangle may then be subdivided and the area of each division calculated. Having determined the areas tributary to each column and knowing the loading for each division of the floor area tributary to each column, the column load is easily enough determined by the principles of moments. For example,- Required to find the load carried by column 11, Fig. 4. page 8. For convenience

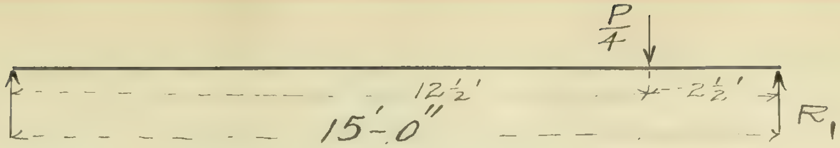
consider the floor to be uniformly loaded except the panel marked B.-B. Where the small beam 20. is located, consider a vault to be so placed that



half it's weight is carried to beam 10. thence to girders 8 and 9 to the columns 10 and 11. The uniform load is easily figured, so the case of the concentrated load only will be considered.

Let P= weight of the vault, then $\frac{P}{2}$ is the part transferred to beam 10. Since $\frac{P}{2}$ is applied at the middle point of beam 10, by the principles of moments $P/4$ is the part transferred to girder 9. Now treating the girder as we did the beam, we have the following conditions for the concentrated

load.



$$1.\quad 15 \times R_1 = 12\tfrac{1}{2} \times P/4$$

$$\therefore R_1 = (12\tfrac{1}{2} \times P/4) \div 15 = \tfrac{5}{24} \times P.$$

$\frac{5 \cdot P}{24}$ = the part of the weight of the vault borne by column 11.

The total weight borne by column 11, is the sum of the uniform load on the portion enclosed in the dotted lines (page 8), plus $5/24$ P.

The weight of the floor consists of the weights of the iron, tile arch, concrete filling, plastering, wood, etc., The iron consists of beams, channels, tie-rods, girders, connections, etc., which may be averaged in pounds per square foot, and in ordinary floors is from 8 to 12 pounds per square foot. The weight of doors, vaults, partitions, etc., may be determined by actual weighing, or by measuring off, or may be figured from the weights of the different materials entering into the construction.

The live load varies from very little to 500 pounds or more per square foot of floor area, depending upon the character of the building. The live load on columns in office buildings vary from 20 to 80 pounds per square foot of floor area. These loads are figured for each floor and then tabulated, and hence the total load on a column at any story is readily found by referring to the schedule of weights.

4. DIMENSIONING OF FOUNDATION.- Before proceeding to dimension the foundation, it is necessary to know the character of the soil upon which the building is to stand. A knowledge of its bearing power is to be had possibly from noting the size and kind of buildings already erected near the building site. If no building of the nature of the one to be built is present, an examination of the soil may be made by boring into the earth with augers, and noting the kind of material passed through, whether clay, sand, gravel, or a combination of these.

Rock soil or rock in its native bed possesses unknown bearing powers, that is, it will sustain any load placed upon it so far is known.

Ordinary soil is a term applied to disintegrated rock, clay, sand and gravel, or any combination of the same.

Sand and gravel in dry beds, in thick layers rank next to rock in bearing power. Clay is safe for moderate loads if kept dry. Quicksand is the poorest of soils for foundations; in fact it is not used for foundation beds unless confined, or reinforced in some way. Very yielding soils, as quicksand, soft clay, etc., are strengthened by driving piling or driving to a solid stratum; or by using layers of sand or gravel in the bottom of the foundation pits, or by sinking caissons to solid rock foundations.

The accompanying table gives the bearing power of soils in tons per square foot of area.

Table I.

Bearing Power of Soils.

Kind of Soils.	Tons per sq ft.
Rock in natural bed, thick layers.	200 or more.
Gravel and Sand well cemented.	8 – 10
Clay dry, in thick beds.	6 – 8
Sand compact, well cemented.	4 – 6
Clay moderately dry, in thick beds.	2 – 4
Clay wet, in thick beds.	1 – 2
Alluvial soil and Quick-sand.	0.5 – 1.0

The footings of a foundation should be designed for the load that comes upon them, and to distribute the pressure over a larger area sufficient to produce uniform settlement in all parts of the building. The footings evidently should not be as wide under an opening as under a solid wall, and when the opening forms a considerable portion of the wall-area the footings underneath are omitted, the weight of the portion of the wall over the opening being transmitted by arches or beams to the footings under the sides of the openings. In designing the footings the center of the wall should be considered vertically over the center of the footing, or preferably a little inside of the center of the footings. Then the walls will be tilted slightly inward making them more stable.

Fig. 4.ª page 14. shows the relative position of the center of the

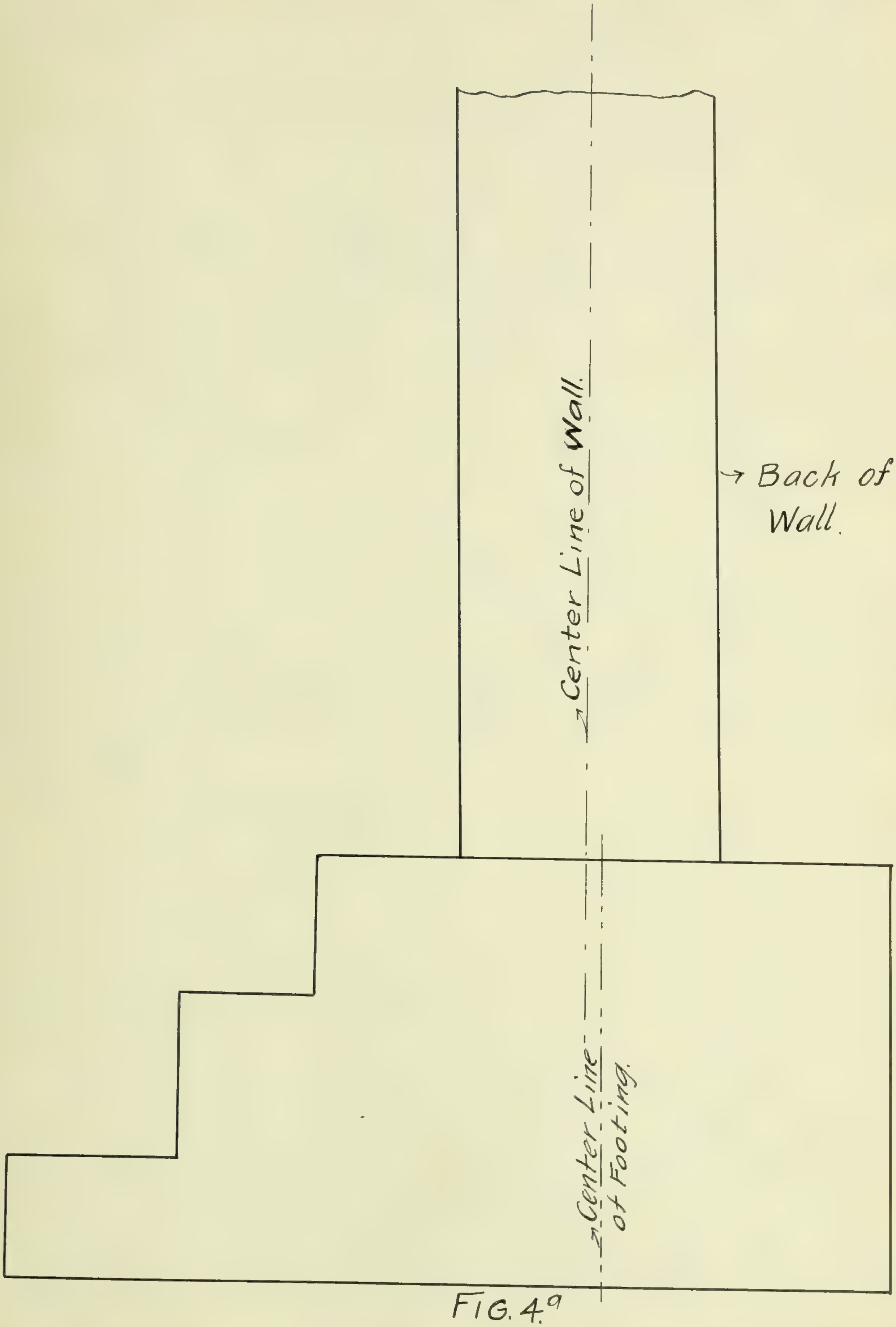


FIG. 4a

wall and the center of the footing. Footings should be stepped up so as to be the most economical, and to furnish as much room in the basement as possible. The customary way of doing this is shown in Fig. 5.[a] page 16. The width of each layer of stone should be such as to make the angle ABC equal approximately to 60°. However there are formulas which give more scientifically the width of each course in the footings, or rather the projection of each layer beyond the edge of the upper layer.

The following example illustrates the usual method of determining the width of the footing as suggested by Fig. 5.[a] Assume a building 45' × 60' to have five stories and a basement, tar and gravel roof, tile-arch floors, and no partitions. Assume there to be two rows of columns spaced 14½' apart both longitud

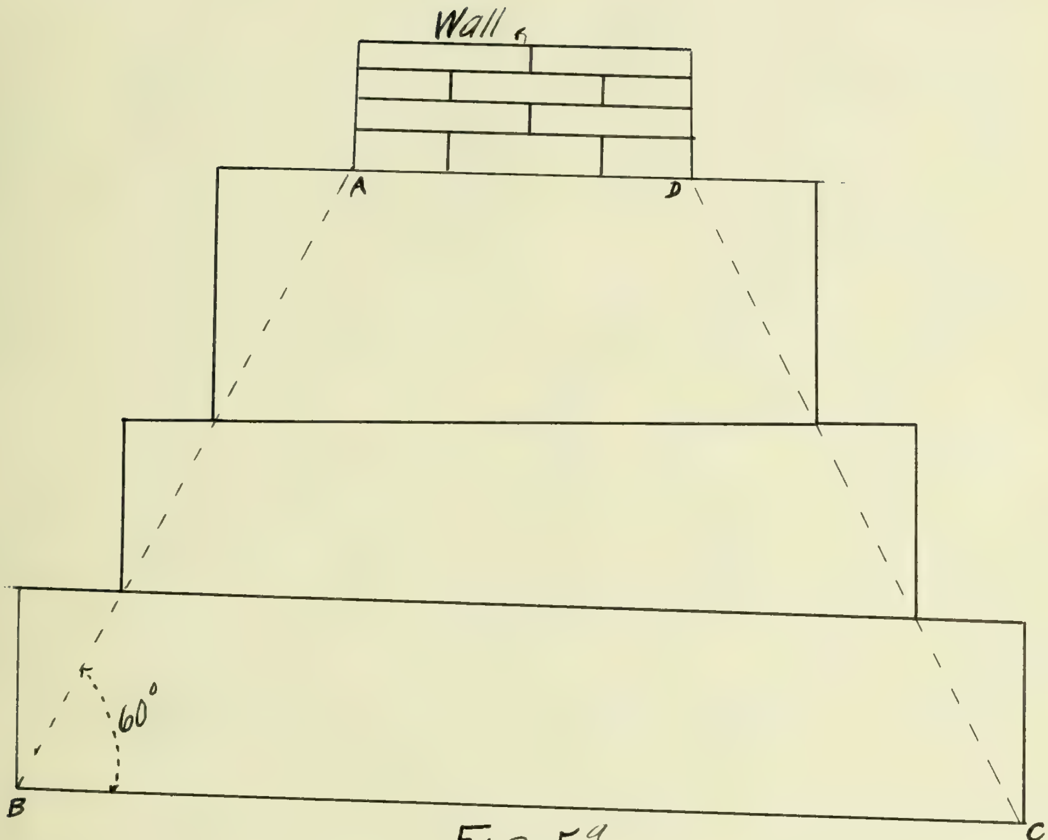


FIG. 5.a

inally and transversely. The walls are 75 feet high, 25 feet being 20 inches thick and 50 feet being 16 inches thick. Since the basement floor is on the ground, its weight is not to be considered. The floor loads on the first and second stories will be assumed at 200 pounds per square foot of floor area, and the other floors will be assumed to carry 150 pounds per square foot. Assume the brick in the wall weighs 120 pounds per cubic foot, tile arch 80 pounds per square foot of floor area, tar and gravel roof 18 pounds per square foot, snow load 12 pounds per square foot.

Then for each foot in length of the side walls the load is:

<u>Dead Load</u>

Walls $\begin{cases} 1'\text{-}8'' \times 1'\text{-}0'' \times 25'\text{-}0'' = 41.7 \text{ cubic feet} \\ 1'\text{-}4'' \times 1'\text{-}0'' \times 50'\text{-}0'' = \underline{66.7} \quad '' \quad '' \end{cases}$

108.4 " "

108.4 cu.ft. @ 120# = 13008 pounds

Floors [80# × 1'-0" × 7¼'] × 5 = 2900 pounds.
Roof [10# × 1'-0" × 7¼'] = 72 "

Live Load

Floors { [200# × 1'-0" × 7¼'] × 2 = 2900 pounds
[150# × 1'-0" × 7¼'] × 3 = 3262 "

Wind Load = 0# — nearly flat roof.
Snow load @ 12# × 1'-0" × 7¼' = 87 pounds.
Total load per foot of wall = 22,229 "

Assume the soil to be moderately dry clay in thick beds. Referring to the table on page 12, the safe load is found to be 3 tons per square foot of area. Now the total load 22,229 pounds divided by 3 tons $= \frac{22,229}{6000} = 3\frac{2}{3}$ as the approximate width in feet of the footing on the bottom. If the foundation is made 6'-0" deep and stepped 1 inch to the foot the top width of the footing will be $2\frac{2}{3}$ feet. The average width of the foundation walls is 3' 2," and the depth is 6' 0." contains 19 cubic feet, and assum-

ing the wall to be good lime-stone rubble masonry weighing 150 lbs. per cubic foot, the weight of the foundation per foot of length is 150 x 19 = 2,850. pounds. Then the total weight per foot upon the soil is 2,850 pounds plus 22,229 pounds = 25,079 pounds. Hence 25,079 ÷ 6000 = 4½ = width of the footing on the bottom. Stone foundation walls should be at least 8 inches thicker than the wall above for a depth of 12' 0" below the curb or grade. It is customary to add 4 inches in width to the foundation for each additional 10' 0" in depth or part thereof. Stone foundations should be at least 1' 4" thick. Table 2 gives values for the thickness of foundation walls in buildings.

Table 2.

Height in Stories	Dwelling, Hotels, etc.		Warehouses.	
	Brick	Stone	Brick	Stone
2	12"-16"	20"	16"	20"
3	16"	20"	20"	24"
4	20"	24"	24"	28"
5	24"	28"	24"	28"
6	24"	28"	28"	32"
7	24"	28"	28"	32"

5. Design of Spandrel Sections.- The term "Spandrel Section" is applied to a vertical cross-section through the exterior wall of a building, showing the construction between the top of a window and the bottom of the window next above. To design the iron construction in a spandrel in the most satisfactory manner, it is necessary that all the data pertaining to the construction be given on the plans, such as, cornice lines, projections, dimensions of terra cotta or stone trimmings, relative heights of window caps and floor lines, the exact positions of the wall lines in the rooms above and below the spandrel sections. The iron should not be exposed anywhere, and should be far enough from the surface to be protected from the fires. The terra cotta is anchored to the iron, and is used as a finishing material. Fig. 4 (page

23, shows a typical spandrel section with the usual iron construction. The left portion of Fig. 4 is a part of the plan as finished. The I beam is a floor beam butting into the wall on the right. The vertical section ABCD, is the wall. The I beam supporting the end of the floor beam and resting in the wall, shows the top of the window below. The channels above are united by cast iron separators between them. To these channels are anchored the trimmings, and on top of the channels and supported by them are the upper wall and trimmings. Care must be taken in designing the spandrel construction to secure the least possible deflection; thus rendering the liability of cracks to appear in the wall a minimum, when completed. The cracks may not injure the building other than

to give it a bad appearance. Pressed brick may be used instead of the terra cotta. When stone window caps are used, they may be carried directly upon the iron: but more generally the window cap is made self supporting, and the load above is supported upon the iron as shown in Fig. 4.

In calculating the load that is to come upon the iron in the spandrel, it is a common practice to consider the weight of the part of the wall between the lower line of the window cap and the top line of the window sill next above, evenly distributed.

The designing of the steel construction for spandrels offers the greatest variety and consequently the most opportunities for invention. Here,

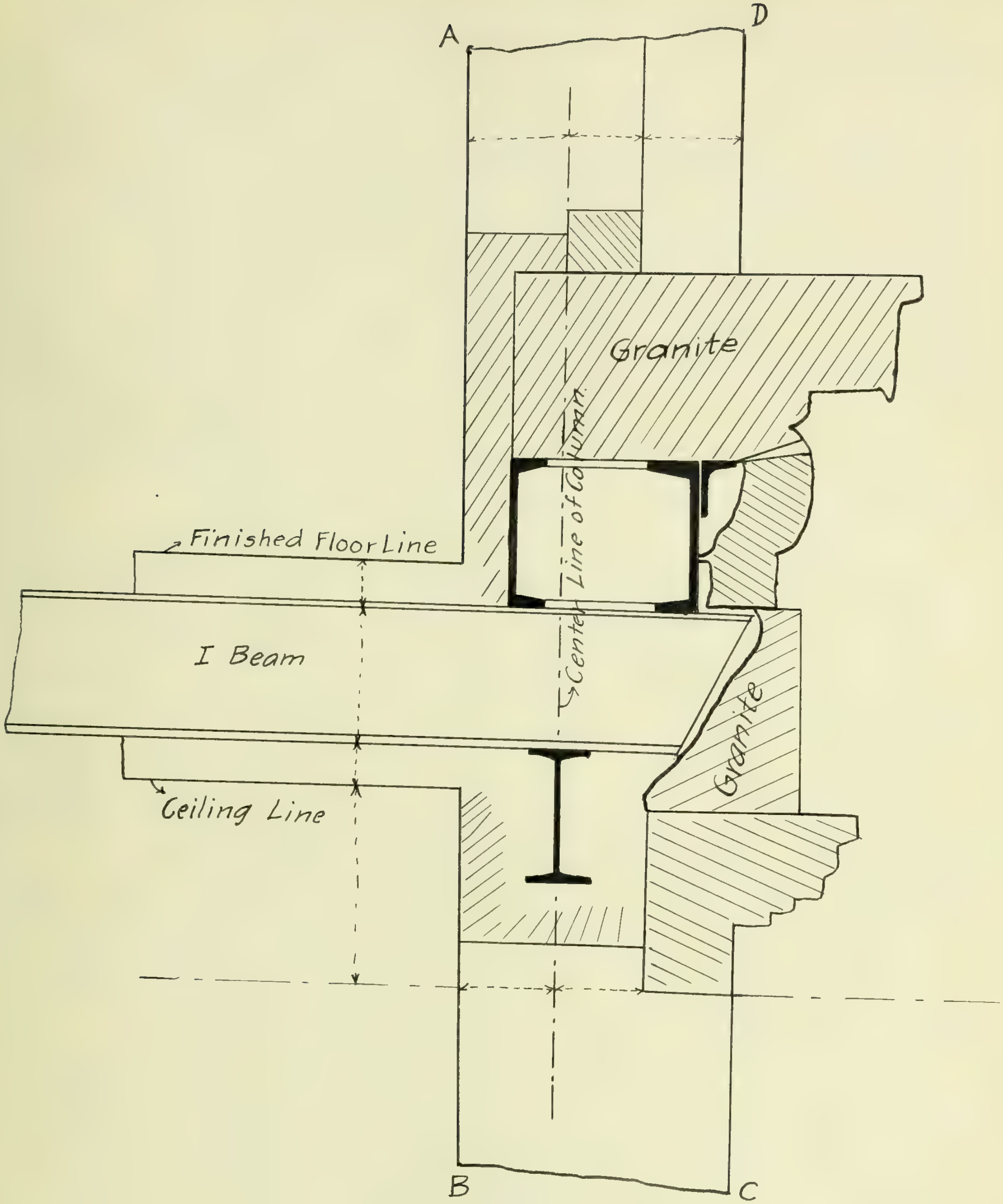


FIG. 4.

Typical Spandrel Construction.

as elsewhere, there are a few broad principles that should be observed:

1. The whole steel construction must be strong enough to carry its load; and each member should be able to carry that part of the load that falls directly upon it.

2. Stiffeness is very desirable, to avoid cracking the stone or other material carried, and hence deep beams or channels are preferable to shallow ones.

3. The steel must afford sufficient bearing area for the material above.

4. Due regard should be given to convenience of erection. For example, a channel and an angle as in Fig. 5. is better than an I beam as in Fig. 6. since with the latter the face brick must be cut to fit around the top flange.

I

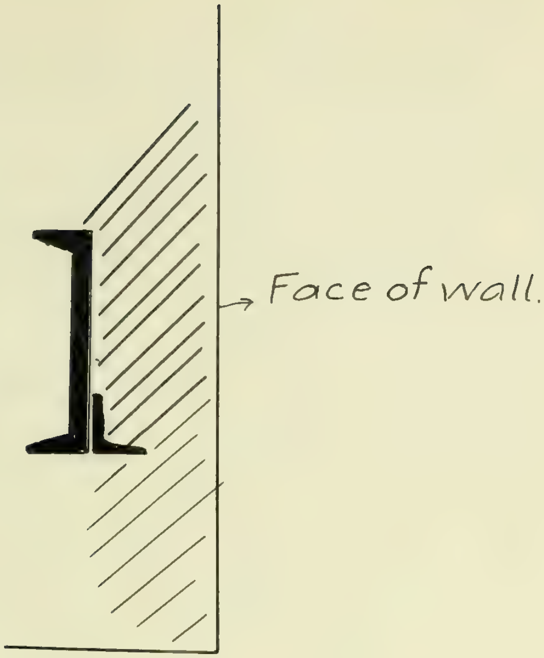


FIG. 5.

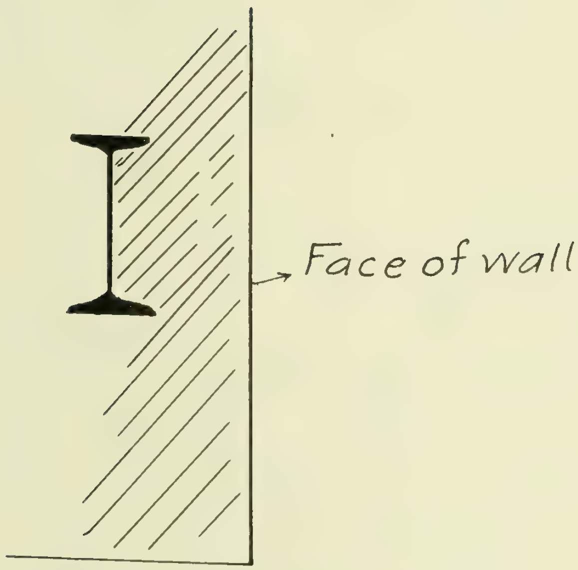


FIG. 6.

5. Where two members are required to give sufficient bearing, it is desirable to have them 9 to 11 inches apart to give space for connecting the spandrel beam to the connecting beams. Another advantage of this construction is that by laying bricks on the bottom flanges between the beams a more thorough fire proofing is secured.

There are a great variety of conditions affecting this part of the design. For example, if the building is high and needs wind bracing, the best place to put it is in the spandrels. For this purpose one may use either a plate girder or a double channel with gussets at the column end. A single plate girder with wide flange angles makes a very good support for brick and terra cotta.

The following example is chosen by the writer to

illustrate how some of the foregoing principles were met in designing the spandrel sections of a large hotel at Atlantic City, New Jersey. The owner required the soil pipes to be placed in the walls and to pass up between the spandrel beams. As the connecting pipe must come in between the ceiling and floor line, the architect had designed a spandrel section like Fig. 7, page 28. To permit the connection of the pipes within the thickness of the floor, would require the cutting of a big hole in the web of the inside channel, which would be very undesirable. The designing engineer found upon inquiring of the plumbing contractor that the scheme proposed was not a practical one, since the connection for the pipes is a big casting like the sketch in

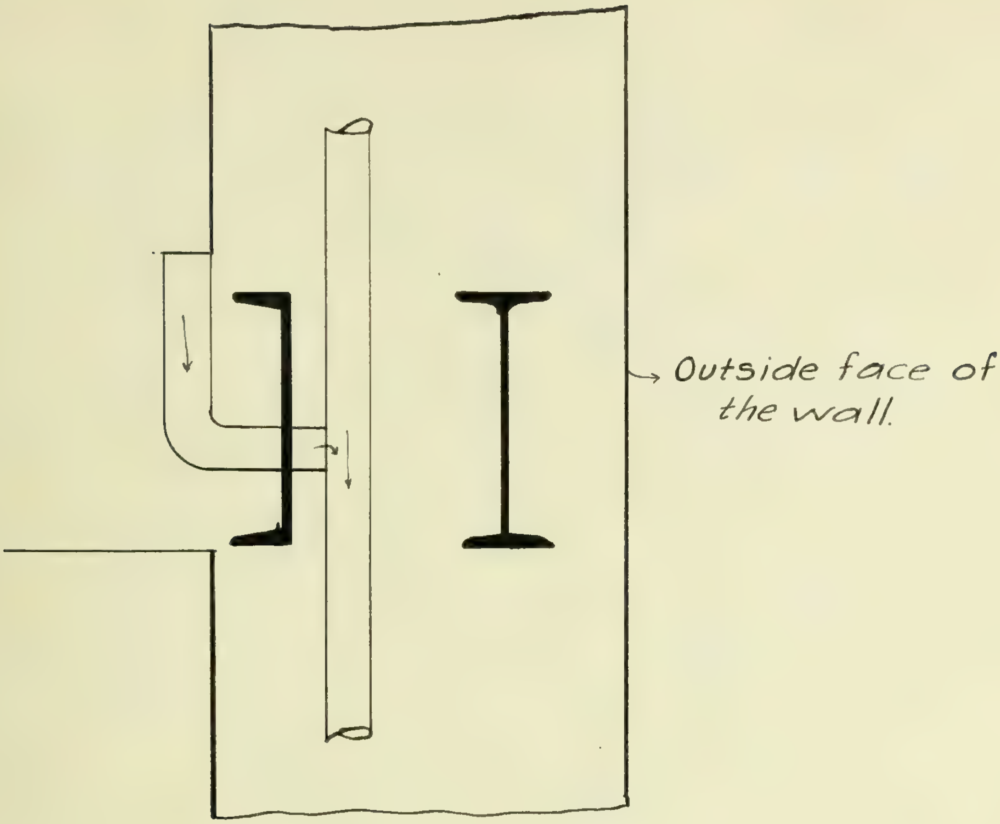


FIG. 7.

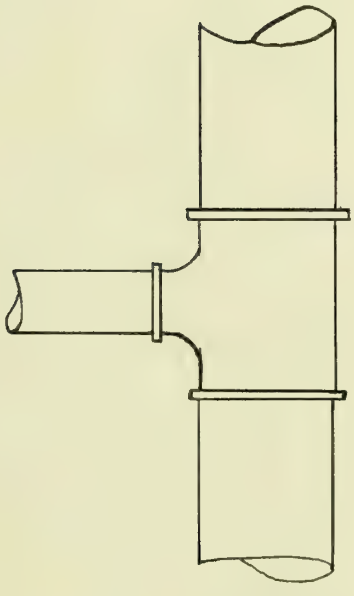


FIG. 8.

Fig. 6, page 23., which must be free to turn about its vertical axis so that it can be screwed to the vertical pipes. Further, the I beam next to the outside wall as shown in Fig 7, violates principle 4. as stated on page 24.— while the inside channel would probably not be strong enough to carry the portion of the wall resting on it together with the floor load from intersecting floor beams. Again, the channel being placed as it is with the back toward the I beam, the brick between the channel and I beam would not be well supported.

To overcome these objectionable features, the designing engineer for Purdy & Henderson, who are designing the steel work for this hotel, used the section shown in Fig. 8, page 30. Fig. 8 is not given as an ideal section, but to show how some of the unusual requirements may

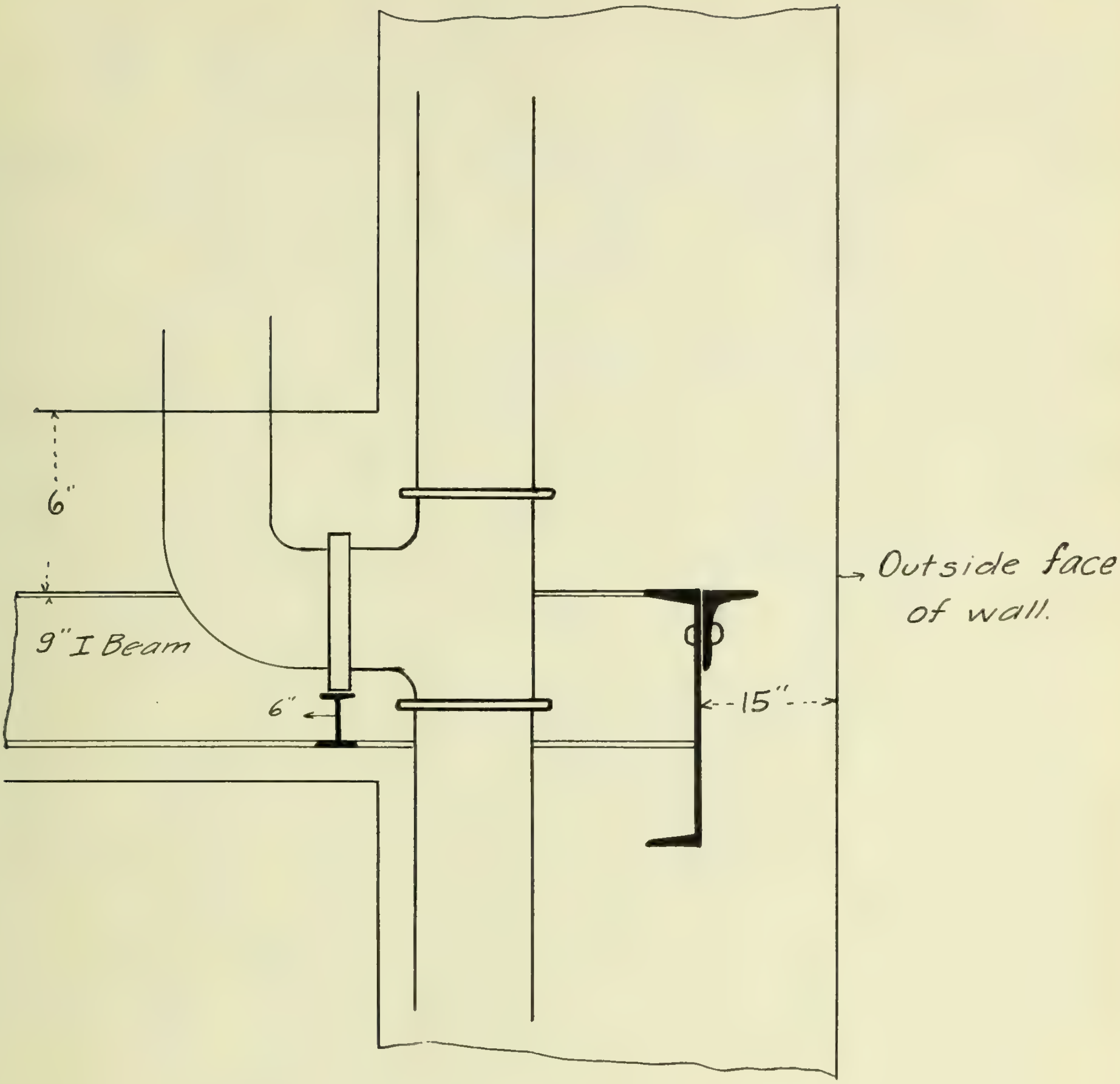


FIG. 9.

be met without departing radically from the ideal arrangement. The principal objection to the section shown in Fig. Fig. 30. is that nearly all of the load is thrown on the channel, which is 8½ inches off the column center. This eccentric load requires extra metal in the columns. It is desirable that either the top or the bottom of the spandrel beams shall agree with the level of the interior beams, as this simplifies the column details. Of course the outside angles must be placed at the proper level for the terra cotta or brick cornices.

Some knowledge of the methods of manufacture and characteristics of materials to be supported is often as necessary as a knowledge of steel construction.

6. DIMENSIONING FLOOR BEAMS.- When a beam is to be designed, the length of the span and loading are known. Knowing this the maximum moment may be found and having assumed the allowable working stress in accordance with engineering practice, the proper size of the beam may be computed. The working stress for beams varies according to the systems of loading. For quiescent loads the allowable stress is usually 16000 pounds per square inch, and for moving loads 12500.

There are several methods in use to determine the proper size of the beam to be used in any case; but in practice it is customary to use one of the three following methods; (1) method of coefficients; (2) method of safe loads; (3) by the use of the well known formula: $M = \frac{SI}{c}$. Each of these

methods are well enough understood that no explanations are necessary. Since the tables in the handbooks are accurately made out, it is much easier in the case of uniform loading, to find the size of the beam by either the method of coefficients or by the method of safe loads than it is by the formula: $M = \frac{SI}{c}$; but in more complicated systems of loading, it is usually the practice to use the formula. The selection of the proper proportions and shapes of beams for the different cases requires much judgment and experience; but in all cases, whatever forms are selected, they must satisfy the above formula.

7. DIMENSIONING THE COLUMNS:- Since the formulas for the strength of columns do not all agree, it is a matter of judgment on the part of the designing engineer which form of section to use for his column, and what dimensions are necessary to give ample strength. The underlying principles seem to be sufficiently established; but every authority has his own treatment of them, his own form of expression, and his own nomenclature. All common formulas are based on a condition of ideal loading which is rarely obtained.

Steel columns fail either by deflecting bodily out of a straight line, or by the buckling of the metal between the rivets or other points of support. Both actions may take place at the

same time; but if the latter occurs alone, it may be an indication that the rivet spacing or the thickness of the metal is insufficient. According to practical experience the safe distance between the centers of the rivets should not exceed in the line of strain sixteen times the thickness of the metal joined, and the distance between the centers of the rivets at right angles to the line of strain should not exceed thirty-two times the thickness of the metal.

The sections shown on page 36 are the more common forms of built columns. Figs. 14, 15, 19, 20, and 21, are called "closed columns," since it is impossible to get at the inner surface. Such columns are not to be used in places where they will be exposed to the weather, since the inner surface is not

Fig. 10.

Fig. 14.

Fig. 18.

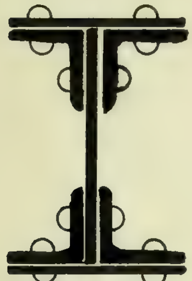


Fig. 11.

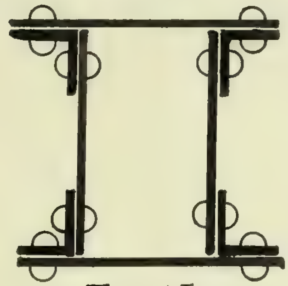


Fig. 15.

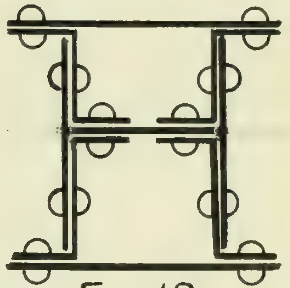


Fig. 19.

Fig. 12.

Fig. 16.

Fig. 20.

Fig. 13.

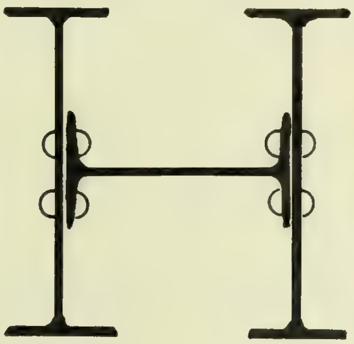


Fig. 17.

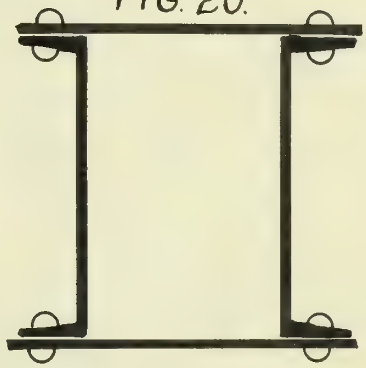


Fig. 21.

accessible for the purpose of repainting in order to prevent corrosion. The other types may be exposed to the weather, since almost their entire surface is accessable for repainting.

Columns must be designed to take the stress due to direct loading, and to wind moment if there be any. In designing the columns care must be taken to provide room for the driving of rivets. The maximum permissible shearing stress on rivets is to be 10000 pounds per square inch for shop rivets. Complete tables of dimensions and safe loads in tons for columns of different lengths, and sections are given in Carnegie's Hand Book. Nearly all the problems of determining the size of columns are worked from the tables given in the Hand Book.

8. WIND BRACING.- Buildings are usually subject to lateral strains from wind forces, and steel-frame buildings are built to such great heights, and are so destitute of the ordinary means of resisting wind forces that it is necessary to brace the frame to give it sufficient rigidity. This can be done in a variety of ways; but the arrangement of the rooms, the architectural features, and other requirements prescribe so greatly that the designer will probably be left with but one way, and be very glad that he has that one.

The bracing, whatever it is, must be vertical, reaching down to some solid connection at the ground. It should be arranged in some regular symmetrical relation to the outlines of the building. For example, if the building is narrow and is braced crosswise with one system of bracing, that system should be midway between the ends of the

building, and if two systems are used they should be equidistant from the ends, the exact distance being unimportant, because the floors, when finished are extremely rigid. The symmetrical arrangement is necessary to secure an equal service of the systems and prevent any tendency to twist.

Figs 22, 23, 24 and 25, page 40, shows in outline several ways in which a system of bracing may be constructed. Horizontal lines indicate floors, and vertical lines indicate columns. The horizontal components of the wind stresses are taken by two latticed channels bars located in the different floors, while the vertical components of the wind stresses are taken by the columns and must be added to the other loads to which the columns are subjected, in determining the sizes of the columns. The style of bracing

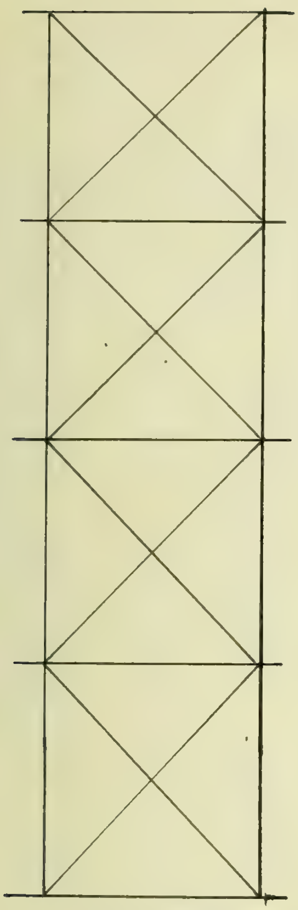


FIG. 22.

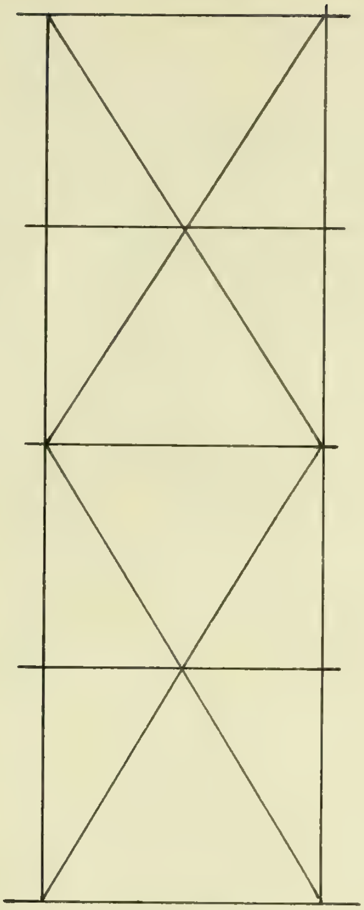


FIG. 23

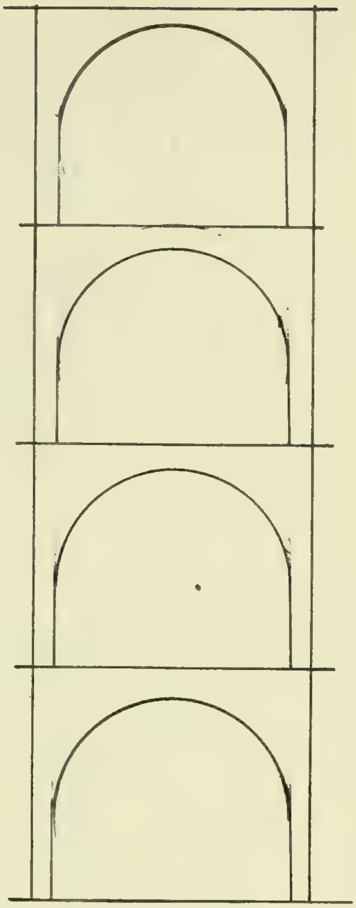


FIG. 24.

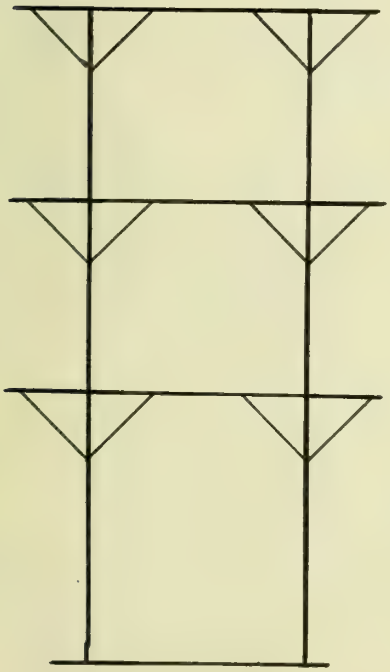


FIG. 25

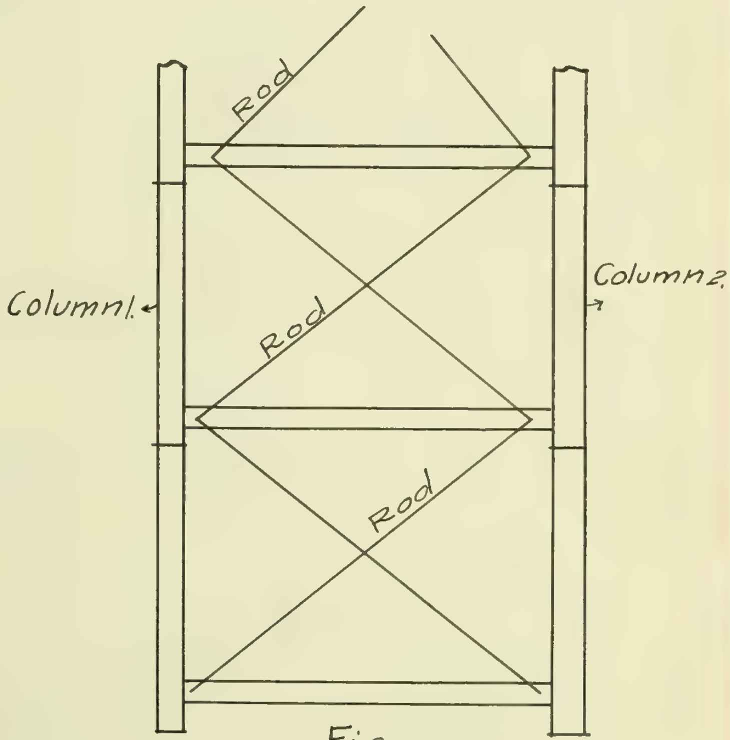


FIG. 26.

shown in Fig. 24. is usually placed between adjacent columns in corridors or passage ways, and extends from the foundation up, from floor to floor to such a height that the stability of the building above is of itself sufficient to resist the wind forces.

Another form of wind bracing consists in running a deep girder all around the building, having riveted connections to the columns in the walls.

The simplest form of bracing is that shown in Fig. 22. of which Fig. 26. is a more detailed view. The arrangement as shown in Fig. 25. if used at all, would probably be made to include more than two columns, and the stresses would vary greatly with the number of columns included in the system. It is not an economical method of stiffening a structure, as it produces heavy bending moments in both the

horizontal struts and in the columns themselves. Methods shown in Figs. 22 and 23, on the other hand, if connections are properly made, do not cause any bending in the columns or in the lateral struts. Every detail in wind bracing should receive the most careful consideration.

9. DETAILS OF CONSTRUCTION.- The term "detailing" as used in the drafting room has a different meaning from that used in the shops. In the former it refers to the making of the shop drawings, while in the latter it refers to the fastening of the angles, plates, etc., to the main members.

A brief discussion of office management and equipment is necessary for a definite understanding of the terms to be used further on in this thesis.

In an office devoted almost exclusively to steel-frame building construction employing from thirty to forty men, the force consists of the following: 1. General manager 2. Chief engineer 3. Chief designer 4. Chief draftsman 5. Checkers 6. Detailers 7. Office boy.

1. The general manager

has sole charge of the office, and management of the business.

2. The chief engineer superintends all constructional designs of importance.

3. The chief designer makes all the more important designs subject to the approval of the chief engineer.

4. The chief draftsman's duty is to see that all work is carefully and accurately done. If these requirements are to be met with the least sacrifice of time and money, the chief draftsman must see that the work of detailing, etc., is properly assigned, i.e. the most difficult work should be assigned to the ablest draftsmen, and the less difficult work should be given to the less experienced draftsmen. The position of chief draftsman in some offices, is made

to pass from one draftsman to another, i.e., one man holds the office for a time, and then another is allowed to take the position. In some cases it is an office gained through merit, i.e., if some one of the draftsmen find a mistake or oversight of any importance made by the chief draftsman, the position is then passed to the man who discovered the mistake. This rule has the effect of stimulating keen observation and careful work among the draftsmen.

5. The duties of the "checkers" are to check the work of the draftsmen as to correct constructional details and broken dimensions. Usually there is but one checker for each job who checks the work for the entire building. There may be ten or twelve detailers working on one building under one

checker. The checker is held more or less responsible for the completion of the job within the specified time, and hence it is to the interest of each checker to see that the work assigned to each detailer is not beyond his ability. Men who have had but little experience in detailing, make rather slow progress at first; hence if the more complicated detailing is assigned to the more experienced draftsmen much time is thereby saved.

6. "Detailers" are the draftsmen who make the shop drawings. The work of detailing may be divided into two classes: 1. detailing beams 2. detailing columns and roof trusses. The less experienced draftsmen as a rule make the floor beam details. These details are usually very simple and easily made. The more

experienced draftsmen are engaged in making the details of the columns and roof trusses. Considerable skill is required in designing the connections for all the different members joining the columns.

7. The duty of the office boy is to keep all the drawings, blue prints, etc., in their proper places in the vaults, and do errands in general. His duties are too numerous to mention here.

Before beginning the detailing, blue prints are made of the plans of the floors showing all the constructional features necessary for the detailers to get a thorough understanding of the connections, size, and numbers of the floor beams with their relative positions when in place.

If any difficulty confronts the detailer in determining what column connections are to be used for the girders and beams framing into the columns, he may with the column detailer agree upon some form of connection and each detailer be thus governed in his designs.

Probably too much space would be required to enter into a complete discussion of the way in which the material is all detailed, so only a few samples will here be given.

The first thing the "beam-detailer" does after being given a blue print of a floor plan, is to make a schedule like that given on page 49. This schedule is 14" x 9" and will contain the record of 400 beams. In the circle at the upper

Page 860

Schedule for 1st Floor
McNeill Building

Beam		Page	Beam		Page	Beam		Page	Beam		Page	Beam		Page
A'	50	321												
A	51	"												
A	52	"												
Z	53	"												
Z	54	"												
Z	55	322												
E	56	"												
E	57	"												
E	58	323												
ψ	59	"												
ψ	60	"												
ψ	61	"												

right hand corner is placed the job number. This building is assumed to be recorded as job number 860. This schedule is for the first floor beams of the building. In the first column are placed the initials or some mark indicating the number of the beams which are being detailed by each draftsman. By this method no beam will be detailed more than once, since it is readily seen which beams have been taken to be detailed by the different draftsmen. The numbers of the beams in the schedule correspond to the numbers of the beams on the blue-print floor plans. Separate schedules are made for the different floors, and different schedules for the columns of the different stories. In the third column is put the

number of the page in the record where a description of the beam is to be found. In this way a page number for each beam is kept, also a job number for each building.

It is very convenient to have these records in case a dispute comes up, when a misfit occurs in erecting the building, as it is thereby easy to locate the blame — whether of the draftsman who made the drawing or of the men at the shop who made the sections.

Having signed for a number of beams, the first thing to determine is the relative position of the beams as they shall be when the building is erected. This information is usually, if not always, given in a note on the blue print. The beams being of

different sizes, the tops and bottoms will bear different relative positions to each other,—some may be flush on top, some flush on bottom, and some neither flush on top nor bottom. To keep the relation of the beams in mind, it is often convenient to make a pencil sketch of the relative positions which is kept for ready reference. This sketch may be made something like that shown in Fig, 27. In this case the

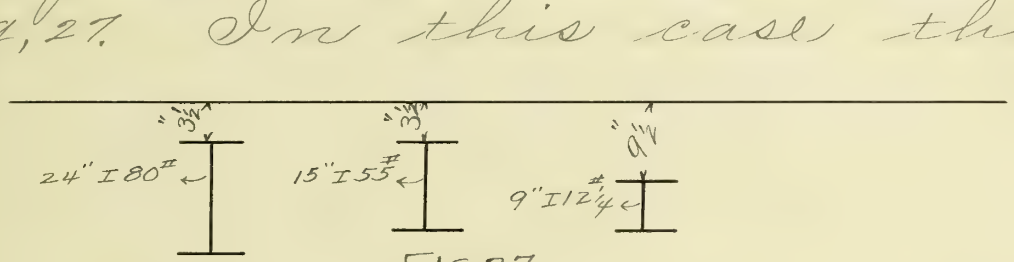


FIG 27.

24 inch I 80 pound and 15 inch I 55 pound beams are flush on top being 3½ inches below the floor line, and the 15 inch I 55 pound and 9 inch I 12¼ pound beams are flush on the bottom. If the detailer is not familiar with the

office's standard details, he secures a copy for ready reference. The standards on page 54 are those used at the office of Purdy and Henderson. The method of using the standards will be illustrated by examples of detailing later.

Office Standards

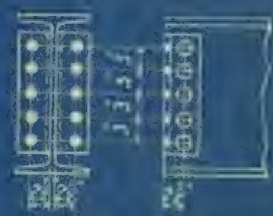
DEPTH	WEIGHT	FLANGE	WEB	AREA	GAUGE a	TANG'T c	DIST. T	GRIP g	DIST. b	DIST. c'	MAX. DIA. RIVETS	STAND. WALL PL.
24"	100#	7¼"	¾"	29.41"	4"	20½"	1⅜"	⅞"	5¾"	7/16	1"	
	95	7 3/16	11/16	27.94	"	"	"	"	5 11/16	7/16		
	90	7⅛	⅝	26.47	"	"	"	"	5⅝	⅜		
	85	7 1/16	9/16	25.00	"	"	"	"	5 9/16	⅜		
	80	7	½	23.32	"	"	"	"	5½	5/16		
20"	100	7¼	⅞	29.41	4	16¼	1 7/16	15/16	5⅞	½	⅞	
	95	7 3/16	13/16	27.94	"	"	"	"	5 13/16	½		
	90	7⅛	¾	26.47	"	"	"	"	5¾	7/16		
	85	7 1/16	11/16	25.00	"	"	"	"	5 11/16	7/16		
	80	7	⅝	23.73	"	"	"	"	5⅝	⅜		
	75	6⅜	⅝	22.06	3½	16¾	1⅜	13/16	5 11/16	7/16		
	70	6 5/16	9/16	20.59	"	"	"	"	5 9/16	⅜		
	65	6¼	½	19.08	"	"	"	"	5½	5/16		
18"	70	6¼	¾	20.59	3½	15	1½	11/16	5¾	7/16	⅞	
	65	6 3/16	⅝	19.12	"	"	"	"	5⅝	⅜		
	60	6 1/16	9/16	17.65	"	"	"	"	5 9/16	⅜		
	55	6	½	15.93	"	"	"	"	5½	5/16		
15"	100	6¾	1 3/16	29.41	3½	10⅝	2 3/16	1 1/16	6 5/16	11/16	⅞	
	95	6 11/16	1 1/16	27.94	"	"	"	"	6 1/16	⅝		
	90	6 9/16	1	26.47	"	"	"	"	6	9/16		
	85	6½	⅞	25.00	"	"	"	"	5⅞	½		
	80	6⅜	[illegible]	23.81	"	"	"	"	5 13/16	½		
	75	6 5/16	[illegible]	22.06	3½	11½	1¾	13/16	5⅞	½	¾	
	70	6 3/16	[illegible]	20.59	"	"	"	"	5¾	7/16		
	65	6⅛	[illegible]	19.12	"	"	"	"	5 11/16	7/16		
	60	6	[illegible]	17.67	"	"	"	"	5⅝	⅜		
	55	5¾	[illegible]	16.18	3	12⅛	1 5/16	⅝	5⅝	⅜		
	50	5⅝	9/16	14.71	"	"	"	"	5 9/16	⅜		
	45	5 9/16	[illegible]	13.24	"	"	"	"	5½	5/16		
	42	5½	[illegible]	12.48	"	"	"	"	5 7/16	¼		
12"	55	5⅝	13/16	16.18	3	9⅛	1 7/16	11/16	5 13/16	½	¾	
	50	5½	11/16	14.71	"	"	"	"	5 11/16	7/16		
	45	5⅜	9/16	13.24	"	"	"	"	5⅝	⅜		
	40	5¼	½	11.84	"	"	"	"	5½	5/16		
	35	5⅛	7/16	10.29	2¾	9⅝	1 3/16	9/16	5 7/16	5/16		
	31½	5	⅜	9.26	"	"	"	"	5⅜	¼		

STANDARD FRAMING

24"

4"×4"×⅜" Ls 1'-6" Ls
WEIGHT 38.4#

18" & 20"

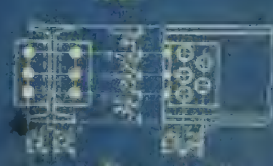


4"×4"×⅜" Ls 1'-3" Lg.
WEIGHT 32#

15"

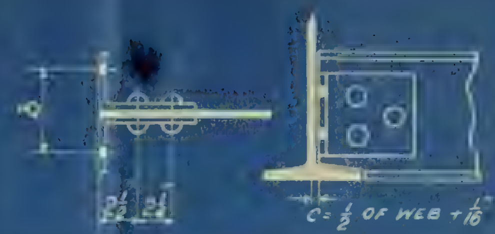
6"×4"×⅜" Ls 0'-10½" Lg.
WEIGHT 28#

12"



6"×4"×⅜" Ls 0'-8" Lg.
WEIGHT 21.4#

LIBRARY
OF THE
UNIVERSITY of ILLINOIS



DEPTH	WEIGHT	FLANGE	WEB	AREA	GAUGE a	TANG'T t	DIST. T	GRIP g	DIST. b	DIST. c	MAX DIA. RIVETS	STAND. WALL PL.
10"	40#	5 1/8"	3/4"	11.76"	2 5/8"	7 7/8"	1 1/16"	1/2"	5 3/4"	7/16"	3/4"	
	35	4 15/16	5/8	10.29	"	"	"	"	5 5/8	3/8		
	30	4 13/16	1/2	8.82	"	"	"	"	5 1/2	5/16		
	25	4 11/16	5/16	7.37	"	"	"	"	5 5/16	1/4		
9"	35	4 3/4	3/4	10.29	2 1/2	7	1	7/16	5 3/4	7/16	3/4	
	30	4 5/8	9/16	8.82	"	"	"	"	5 9/16	3/8		
	25	4 7/16	7/16	7.35	"	"	"	"	5 7/16	5/16		
	21	4 5/16	5/16	6.31	"	"	"	"	5 5/16	1/4		
8"	25 1/2	4 1/4	9/16	7.50	2 1/4	6 1/8	13/16	7/16	5 9/16	3/8	3/4	
	23	4 3/16	7/16	6.76	"	"	"	"	5 7/16	5/16		
	20 1/2	4 1/8	3/8	6.03	"	"	"	"	5 3/8	1/4		
	18	4	5/16	5.33	"	"	"	"	5 5/16	3/16		
7"	20	3 7/8	1/2	5.88	2 1/4	5 1/4	7/8	3/8	5 1/2	5/16	5/8	
	17 1/2	3 3/4	3/8	5.15	"	"	"	"	5 3/8	1/4		
	15	3 11/16	1/4	4.42	"	"	"	"	5 1/4	3/16		
6"	17 1/4	3 9/16	1/2	5.07	2	4 3/8	13/16	3/8	5 1/2	5/16	5/8	
	14 3/4	3 7/16	3/8	4.34	"	"	"	"	5 3/8	1/4		
	12 1/4	3 5/16	1/4	3.61	"	"	"	"	5 1/4	3/16		
5"	14 3/4	3 5/16	1/2	4.34	1 3/4	3 1/2	3/4	5/16	5 1/2	5/16	1/2	
	12 1/4	3 1/8	3/8	3.60	"	"	"	"	5 3/8	1/4		
	9 3/4	3	1/4	2.87	"	"	"	"	5 1/4	3/16		
4"	10 1/2	2 7/8	7/16	3.09	1 1/2	2 5/8	11/16	5/16	5 7/16	5/16	1/2	
	9 1/2	2 13/16	3/8	2.79	"	"	"	"	5 3/8	1/4		
	8 1/2	2 3/4	1/4	2.50	"	"	"	"	5 1/4	3/16		
	7 1/2	2 11/16	3/16	2.21	"	"	"	"	5 3/16	1/8		
3"	7 1/2	2 1/2	3/8	2.21	1 7/16	1 3/4	5/8	1/4	5 3/8	1/4	3/8	
	6 1/2	2 7/16	1/4	1.91	"	"	"	"	5 1/4	3/16		
	5 1/2	2 5/16	3/16	1.63	"	"	"	"	5 3/16	1/8		

STANDARD FRAMING

7", 8", 9" & 10"

6" x 4" x 3/8" Ls 0'-5" LG.
WEIGHT 13.8#

5" & 6"

6" x 4" x 3/8" Ls 0'-3" LG.
WEIGHT 8.2#

3" & 4"

6" x 4" x 3/8" Ls 0'-1 3/4"
WEIGHT 5.6#

THE WEIGHTS OF CONNECTIONS INCLUDE SHOP AND FIELD RIVETS.

LIBRARY
OF THE
UNIVERSITY of ILLINOIS

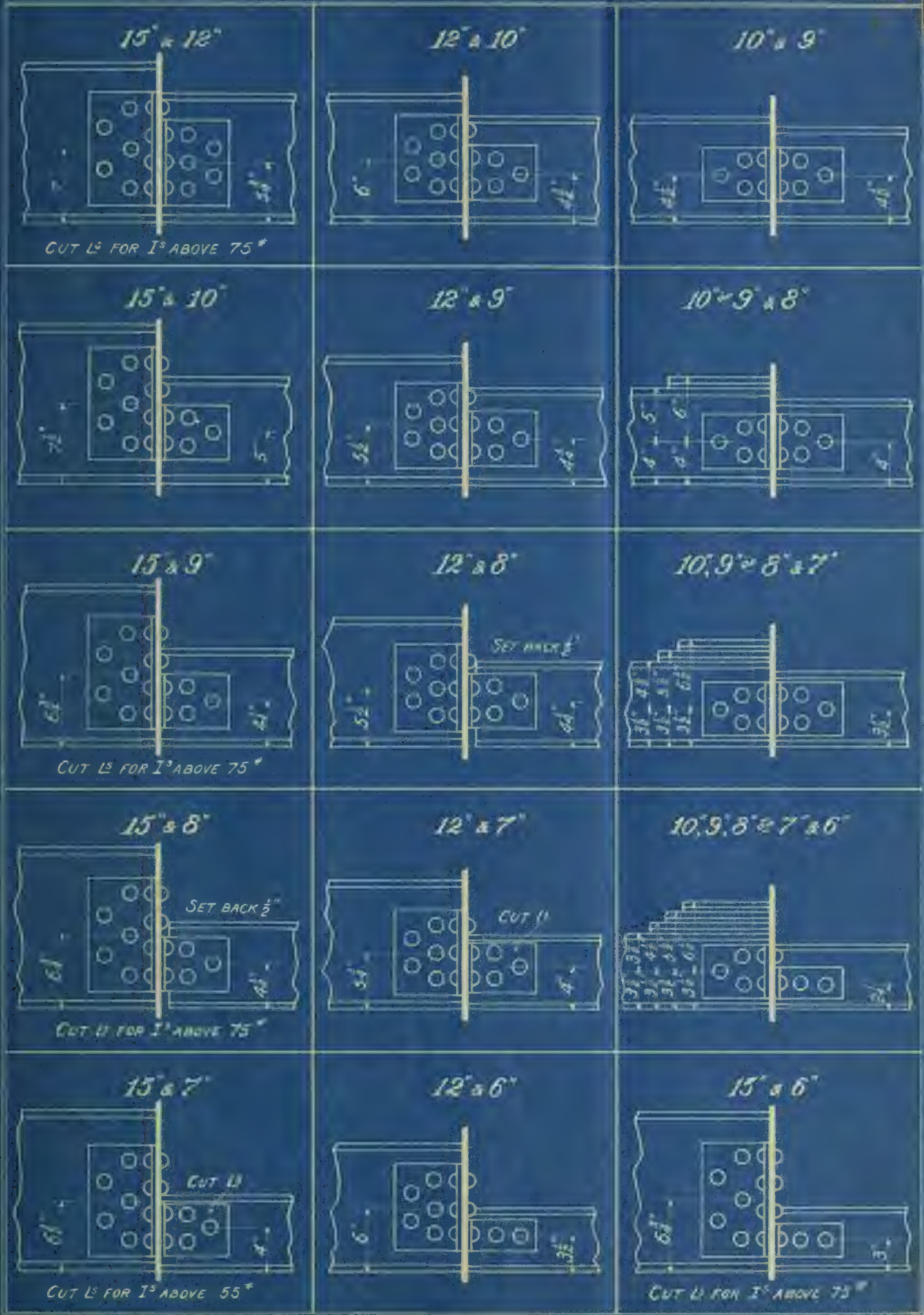
FRAMING SAME AS FOR I BEAMS (EXCEPT AS SHOWN)

DEPTH	WEIGHT	FLANGE	WEB	AREA	GAUGE a	TANGT t	DIST T	GRIP g	DIST b	DIST c	MAX. DIA RIVETS
15"	55"	3 13/16"	13/16"	16.18"	2 1/4	12 1/4"	1 5/8"	5/8"	5 13/16	7/8"	3/4"
	50	3 3/4	3/4	14.71	2 1/4	"	"	"	5 3/4	13/16	
	45	3 5/8	5/8	13.24	2 1/4	"	"	"	5 5/8	11/16	
	40	3 1/2	1/2	11.76	1 7/8	"	"	11/16	5 1/2	9/16	
	35	3 7/16	7/16	10.29	1 7/8	"	"	"	5 7/16	1/2	
	33	3 3/8	3/8	9.90	1 7/8	"	"	"	5 3/8	7/16	
12"	40	3 7/16	3/4	11.76	2	9 3/4	1 1/8"	1/2	5 1/4	13/16	3/4"
	35	3 5/16	5/8	10.29	2	"	"	"	5 5/8	11/16	
	30	3 3/16	1/2	8.82	2	"	"	"	5 1/2	9/16	
	25	3 1/16	3/8	7.35	1 3/4	"	"	"	5 3/8	7/16	
	20 1/2	2 15/16	5/16	6.03	1 3/4	"	"	"	5 5/16	3/8	
10"	35	3 3/16	13/16	10.29	2	8	1	1/2	5 13/16	7/8	3/4"
	30	3 1/16	11/16	8.82	2	"	"	"	5 11/16	3/4	
	25	2 7/8	1/2	7.35	2	"	"	"	5 1/2	9/16	
	20	2 3/4	3/8	5.88	1 1/2	"	"	7/16	5 3/8	7/16	
	15	2 5/8	1/4	4.46	1 1/2	"	"	"	5 1/4	5/16	
9"	25	2 13/16	5/8	7.35	1 3/4	7 1/8	13/16	1/2	5 5/8	11/16	3/4"
	20	2 5/8	7/16	5.88	1 3/4	"	"	"	5 1/2	1/2	
	15	2 1/2	5/16	4.41	1 1/2	"	"	7/16	5 5/16	3/8	
	13 1/4	2 7/16	1/4	3.89	1 1/2	"	"	"	5 1/4	5/16	
8"	21 1/4	2 5/8	9/16	6.25	1 1/2	6 1/4	7/8	1/2	5 11/16	5/8	3/4"
	18 3/4	2 1/2	1/2	5.51	1 1/2	"	"	"	5 1/2	9/16	
	16 1/4	2 7/16	3/8	4.78	1 1/2	"	"	"	5 7/16	7/16	
	13 3/4	2 3/8	5/16	4.04	1 1/4	"	"	"	5 3/8	3/8	
	11 1/4	2 1/4	1/4	3.35	1 1/4	"	"	"	5 1/4	5/16	
7"	19 3/4	2 1/2	5/8	5.81	1 1/2	5 3/8	13/16	3/8	5 5/8	11/16	5/8"
	17 1/4	2 7/16	1/2	5.07	1 1/2	"	"	"	5 1/2	9/16	
	14 3/4	2 5/16	7/16	4.34	1 1/4	"	"	"	5 7/16	1/2	
	12 1/4	2 3/16	5/16	3.60	1 1/4	"	"	"	5 5/16	3/8	
	9 3/4	2 1/8	3/16	2.85	1 1/4	"	"	"	5 1/4	1/4	
6"	15 1/2	2 5/16	9/16	4.56	1 3/8	4 3/8	13/16	3/8	5 9/16	5/8	5/8"
	13	2 3/16	7/16	3.82	1 3/8	"	"	"	5 7/16	1/2	
	10 1/2	2 1/16	5/16	3.09	1 3/8	"	"	"	5 5/16	3/8	
	8	1 15/16	3/16	2.38	1 3/8	"	"	"	5 3/16	1/4	
5"	11 1/2	2 1/16	1/2	3.38	1 1/4	3 1/2	3/4	3/8	5 1/2	9/16	1/2"
	9	1 7/8	5/16	2.65	1 1/4	"	"	"	5 5/16	3/8	
	6 1/2	1 3/4	3/16	1.95	1	"	"	"	5 3/16	1/4	
4"	7 1/4	1 3/4	5/16	2.13	1	2 5/8	11/16	5/16	5 5/16	3/8	1/2"
	6 1/4	1 5/8	1/4	1.84	1	"	"	"	5 1/4	5/16	
	5 1/4	1 9/16	3/16	1.55	1	"	"	"	5 3/16	1/4	
3"	6	1 5/8	3/8	1.76	15/16	1 3/4	5/8	1/4	5 3/8	7/16	3/8"
	5	1 1/2	1/4	1.47	15/16	"	"	"	5 1/4	5/16	
	4	1 7/16	3/16	1.19	13/16	"	"	"	5 3/16	1/4	

LIBRARY
OF THE
UNIVERSITY of ILLINOIS

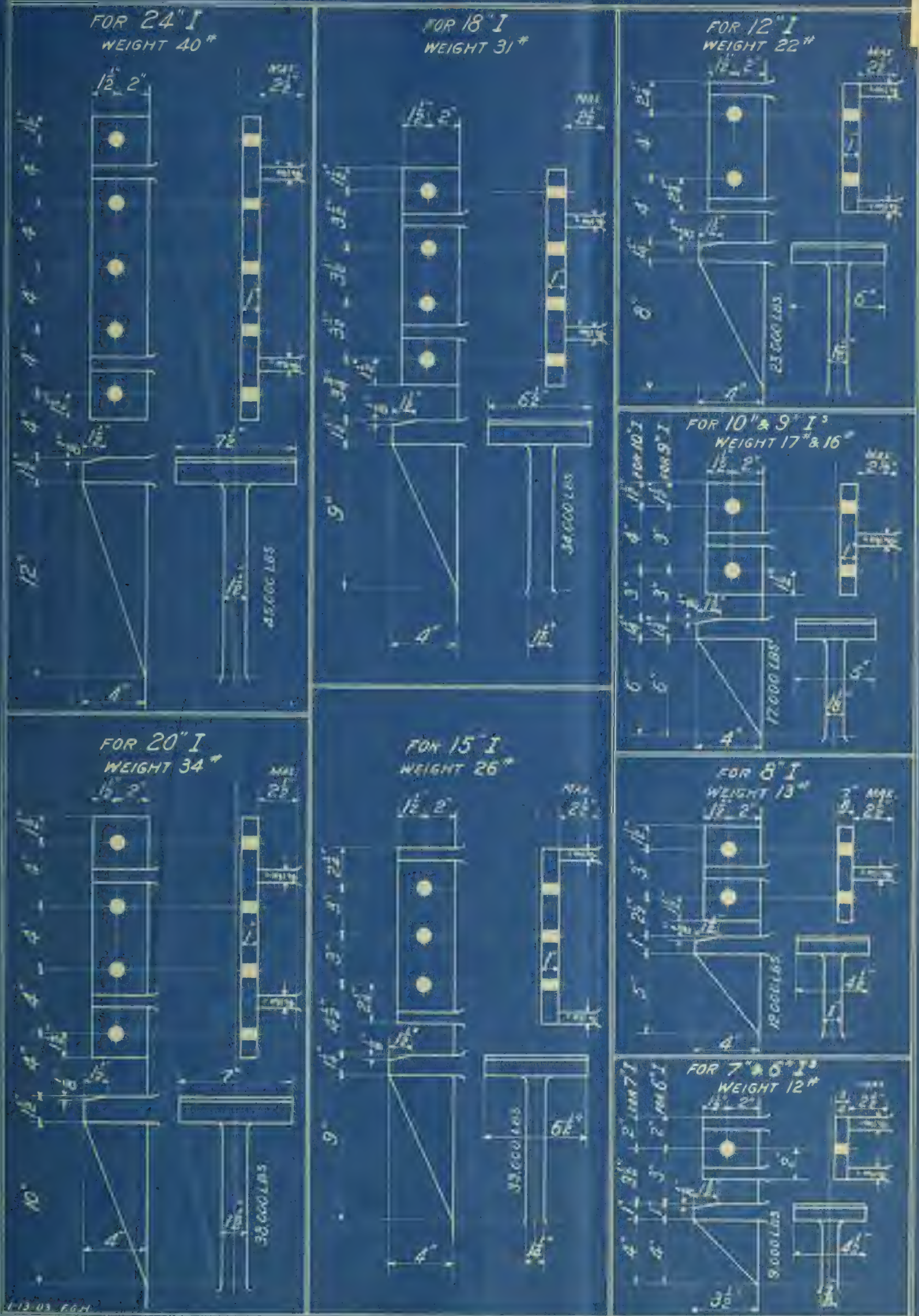
CONNECTIONS FOR DIFFERENT DEPTHS OF BEAMS FRAMING OPPOSITE.

STANDARD CONN. ⅃S TO BE USED ON LARGER BEAMS, UNLESS GAUGE EXCEEDS $2\frac{3}{4}''$ ON SPECIAL ⅃S OF SMALLER BEAMS.



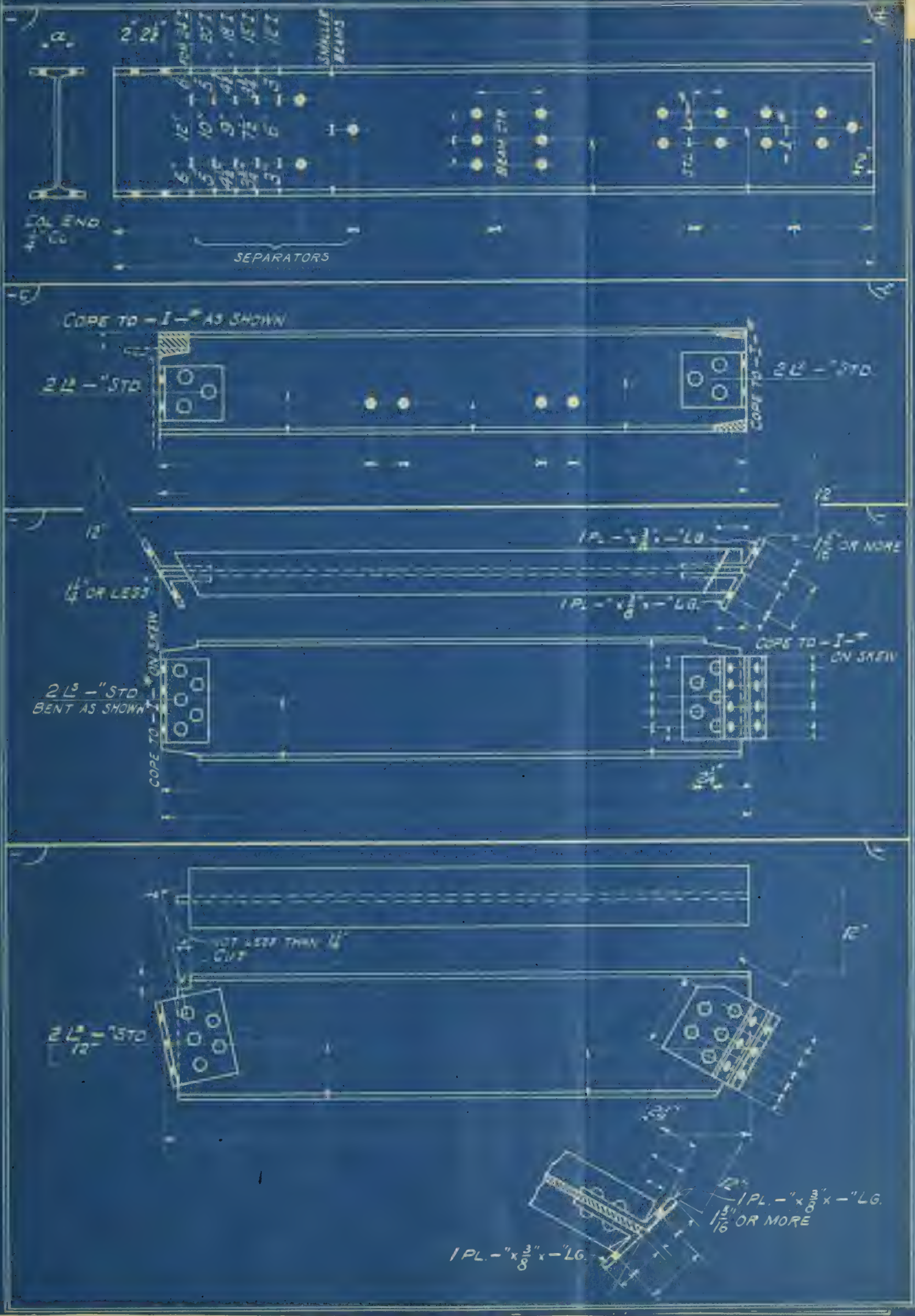
LIBRARY
OF THE
UNIVERSITY OF ILLINOIS

STANDARD CONNECTIONS FOR CAST IRON COLUMNS



LIBRARY
OF THE
UNIVERSITY of ILLINOIS

BEAM DETAILING



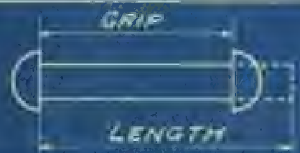
LIBRARY
OF THE
UNIVERSITY of ILLINOIS

SIZES OF RIVET HEADS AND CLEARANCES FOR MACHINE DRIVING.

a	1/2"	5/8"	3/4"	7/8"	1"
H	3/8	15/32	9/16	21/32	3/4
R	7/16	17/32	5/8	23/32	13/16
D	7/8	1 1/16	1 1/4	1 7/16	1 5/8
D1	13/16	1	1 3/16	1 3/8	1 9/16
h	1/4	5/16	3/8	7/16	1/2

"A" MUST NOT BE LESS THAN 1/4" + 1/2 D

LENGTH OF RIVETS FOR VARIANT GRIPS



Plain Rivets

GRIP	DIAMETER 1/2"	5/8"	3/4"	7/8"	1"
	LENGTH				
1/2"	1 1/2"	1 1/2	1 7/8	2	2 1/8"
5/8	1 5/8	1 7/8	2	2 1/8	2 1/4
3/4	1 3/4	2	2 1/8	2 1/4	2 3/8
7/8	1 7/8	2 1/8	2 1/4	2 3/8	2 1/2
1	2	2 1/4	2 3/8	2 1/2	2 5/8
1 1/8	2 1/8	2 3/8	2 1/2	2 5/8	2 3/4
1 1/4	2 1/4	2 1/2	2 5/8	2 3/4	2 7/8
1 3/8	2 3/8	2 5/8	2 3/4	2 7/8	3
1 1/2	2 5/8	2 7/8	3	3 1/8	3 1/4
1 5/8	2 3/4	3	3 1/8	3 1/4	3 3/8
1 3/4	2 7/8	3 1/8	3 1/4	3 3/8	3 1/2
1 7/8	3	3 1/4	3 3/8	3 1/2	3 5/8
2	3 1/8	3 3/8	3 1/2	3 5/8	3 3/4
2 1/8	3 1/4	3 1/2	3 5/8	3 3/4	3 7/8
2 1/4	3 3/8	3 5/8	3 3/4	3 7/8	4
2 3/8	3 1/2	3 3/4	3 7/8	4	4 1/8
2 1/2	3 5/8	3 7/8	4	4 1/8	4 1/4
2 5/8	3 3/4	4	4 1/8	4 1/4	4 3/8
2 3/4	3 7/8	4 1/8	4 1/4	4 3/8	4 1/2
2 7/8	4	4 1/4	4 3/8	4 1/2	4 5/8
3	4 1/4	4 1/2	4 5/8	4 3/4	4 7/8
3 1/8	4 3/8	4 5/8	4 3/4	4 7/8	5
3 1/4	4 1/2	4 3/4	4 7/8	5	5 1/8
3 3/8	4 5/8	4 7/8	5	5 1/8	5 1/4
3 1/2	4 3/4	5	5 1/8	5 1/4	5 3/8
3 5/8	4 7/8	5 1/8	5 1/4	5 3/8	5 1/2
3 3/4	5	5 1/4	5 3/8	5 1/2	5 5/8
3 7/8	5 1/8	5 3/8	5 1/2	5 5/8	5 3/4
4	5 1/4	5 1/2	5 5/8	5 3/4	5 7/8
4 1/8	5 3/8	5 5/8	5 3/4	5 7/8	6
4 1/4	5 1/2	5 3/4	5 7/8	6	6 1/8
4 3/8	5 5/8	5 7/8	6	6 1/8	6 1/4
4 1/2	5 3/4	6	6 1/8	6 3/8	6 1/2
4 5/8	6	6 1/4	6 3/8	6 1/2	6 5/8
4 3/4	6 1/8	6 3/8	6 1/2	6 5/8	6 3/4
4 7/8	6 1/4	6 1/2	6 5/8	6 3/4	6 7/8
5	6 3/8	6 5/8	6 3/4	6 7/8	7
5 1/8	6 1/2	6 3/4	6 7/8	7	7 1/8
5 1/4	6 5/8	6 7/8	7	7 1/8	7 1/4

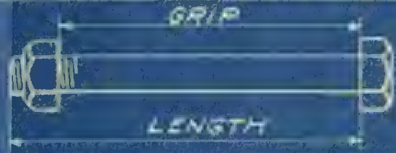
Countersunk Rivets

GRIP	DIAMETER 1/2"	5/8"	3/4"	7/8"	1"
	LENGTH				
1/2"	1 1/8"	1 1/4	1 1/4"	1 3/8"	1 1/2
5/8	1 1/4	1 3/8	1 3/8	1 1/2	1 1/2
3/4	1 3/8	1 1/2	1 1/2	1 5/8	1 5/8
7/8	1 1/2	1 5/8	1 5/8	1 3/4	1 3/4
1	1 5/8	1 3/4	1 3/4	1 7/8	1 7/8
1 1/8	1 3/4	1 7/8	1 7/8	2	2
1 1/4	1 7/8	2	2	2 1/8	2 1/8
1 3/8	2	2 1/8	2 1/8	2 1/4	2 1/4
1 1/2	2 1/8	2 1/4	2 3/8	2 3/8	2 3/8
1 5/8	2 1/4	2 3/8	2 1/2	2 1/2	2 1/2
1 3/4	2 3/8	2 1/2	2 5/8	2 5/8	2 5/8
1 7/8	2 1/2	2 5/8	2 3/4	2 3/4	2 3/4
2	2 5/8	2 3/4	2 7/8	2 7/8	3
2 1/8	2 3/4	2 7/8	3	3	3 1/8
2 1/4	2 7/8	3	3 1/8	3 1/8	3 1/4
2 3/8	3	3 1/8	3 1/4	3 1/4	3 3/8
2 1/2	3 1/4	3 1/4	3 3/8	3 3/8	3 1/2
2 5/8	3 3/8	3 3/8	3 1/2	3 1/2	3 5/8
2 3/4	3 1/2	3 1/2	3 5/8	3 5/8	3 3/4
2 7/8	3 5/8	3 5/8	3 3/4	3 3/4	3 7/8
3	3 3/4	3 7/8	3 7/8	4	4 1/8
3 1/8	3 7/8	4	4	4 1/8	4 1/4
3 1/4	4	4 1/8	4 1/8	4 1/4	4 3/8
3 3/8	4 1/8	4 1/4	4 1/4	4 3/8	4 1/2
3 1/2	4 1/4	4 3/8	4 3/8	4 1/2	4 5/8
3 5/8	4 3/8	4 1/2	4 1/2	4 5/8	4 3/4
3 3/4	4 1/2	4 5/8	4 5/8	4 3/4	4 7/8
3 7/8	4 5/8	4 3/4	4 3/4	4 7/8	5
4	4 3/4	4 7/8	4 7/8	5	5 1/8
4 1/8	4 7/8	5	5	5 1/8	5 1/4
4 1/4	5	5 1/8	5 1/8	5 1/4	5 3/8
4 3/8	5 1/8	5 1/4	5 1/4	5 3/8	5 1/2
4 1/2	5 1/4	5 3/8	5 3/8	5 1/2	5 5/8
4 5/8	5 3/8	5 1/2	5 1/2	5 5/8	5 3/4
4 3/4	5 1/2	5 5/8	5 5/8	5 3/4	5 7/8
4 7/8	5 5/8	5 3/4	5 3/4	5 7/8	6
5	5 3/4	6	6	6	6 1/8
5 1/8	5 7/8	6 1/8	6 1/8	6 1/8	6 1/4
5 1/4	6	6 1/4	6 1/4	6 1/4	6 3/8

LIBRARY
OF THE
UNIVERSITY of ILLINOIS

SIZES OF BOLT HEADS AND NUTS.

d	1/2"	5/8"	3/4"	7/8"	1"
SD	7/8	1 1/16	1 [illegible]/16	1 [illegible]/16	1 [illegible]
LD	1	1 [illegible]/16	1 [illegible]/16	1 [illegible]/16	2
LD'	1 1/4	1 [illegible]/16	1 [illegible]/16	2 [illegible]	2 [illegible]
T	1/2	5/8	3/4	7/8	1
T'	7/16	[illegible]/16	[illegible]/16	[illegible]/16	[illegible]



LENGTHS OF BOLTS FOR VARIANT GRIPS

GRIP	DIAMETER 1/2"	5/8"	3/4"	7/8"	1"
	LENGTH				
1/2	1 1/4	1 1/4	1 1/2	1 1/2	1 3/4
5/8	1 1/2	1 1/2	1 1/2	1 3/4	1 3/4
3/4	1 1/2	1 1/2	1 3/4	1 3/4	2
7/8	1 1/2	1 3/4	1 3/4	2	2
1	1 3/4	1 3/4	2	2	2 1/4
1 1/8	1 3/4	2	2	2 1/4	2 1/4
1 1/4	2	2	2 1/4	2 1/4	2 1/2
1 3/8	2	2 1/4	2 1/4	2 1/2	2 1/2
1 1/2	2 1/4	2 1/4	2 1/2	2 1/2	2 3/4
1 5/8	2 1/4	2 1/2	2 1/2	2 3/4	2 3/4
1 3/4	2 1/2	2 1/2	2 3/4	2 3/4	3
1 7/8	2 1/2	2 3/4	2 3/4	3	3
2	2 3/4	2 3/4	3	3	3 1/4
2 1/8	2 3/4	3	3	3 1/4	3 1/4
2 1/4	3	3	3 1/4	3 1/4	3 1/2
2 3/8	3	3 1/4	3 1/4	3 1/2	3 1/2
2 1/2	3 1/4	3 1/4	3 1/2	3 1/2	3 3/4
2 5/8	3 1/4	3 1/2	3 1/2	3 3/4	3 3/4
2 3/4	3 1/2	3 1/2	3 3/4	3 3/4	4
2 7/8	3 1/2	3 3/4	3 3/4	4	4
3	3 3/4	3 3/4	4	4	4 1/4
3 1/8	3 3/4	4	4	4 1/4	4 1/4
3 1/4	4	4	4 1/4	4 1/4	4 1/2
3 3/8	4	4 1/4	4 1/4	4 1/2	4 1/2
3 1/2	4 1/4	4 1/4	4 1/2	4 1/2	4 3/4
3 5/8	4 1/4	4 1/2	4 1/2	4 3/4	4 3/4
3 3/4	4 1/2	4 1/2	4 3/4	4 3/4	5
3 7/8	4 1/2	4 3/4	4 3/4	5	5
4	4 3/4	4 3/4	5	5	5 1/4
4 1/8	4 3/4	5	5	5 1/4	5 1/4
4 1/4	5	5	5 1/4	5 1/4	5 1/2
4 3/8	5	5 1/4	5 1/4	5 1/2	5 1/2
4 1/2	5 1/4	5 1/4	5 1/2	5 1/2	5 3/4
4 5/8	5 1/4	5 1/2	5 1/2	5 3/4	5 3/4
4 3/4	5 1/2	5 1/2	5 3/4	5 3/4	6
4 7/8	5 1/2	5 3/4	5 3/4	6	6
5	5 3/4	5 3/4	6	6	6 1/4
5 1/8	5 3/4	6	6	6 1/4	6 1/4
5 1/4	6	6	6 1/4	6 1/4	6 1/2

GRIP	DIAMETER 1/2"	5/8"	3/4"	7/8"	1"
	LENGTH				
5 3/8	6	6 1/4	6 1/4	6 1/2	6 1/2
5 1/2	6 1/4	6 1/4	6 1/2	6 1/2	6 3/4
5 5/8	6 1/4	6 1/2	6 1/2	6 3/4	6 3/4
5 3/4	6 1/2	6 1/2	6 3/4	6 3/4	7
5 7/8	6 1/2	6 3/4	6 3/4	7	7
6	6 3/4	6 3/4	7	7	7 1/4
6 1/8	6 3/4	7	7	7 1/4	7 1/4
6 1/4	7	7	7 1/4	7 1/4	7 1/2
6 3/8	7	7 1/4	7 1/4	7 1/2	7 1/2
6 1/2	7 1/4	7 1/4	7 1/2	7 1/2	7 3/4
6 5/8	7 1/4	7 1/2	7 1/2	7 3/4	7 3/4
6 3/4	7 1/2	7 1/2	7 3/4	7 3/4	8
6 7/8	7 1/2	7 3/4	7 3/4	8	8
7	7 3/4	7 3/4	8	8	8 1/4
7 1/8	7 3/4	8	8	8 1/4	8 1/4
7 1/4	8	8	8 1/4	8 1/4	8 1/2
7 3/8	8	8 1/4	8 1/4	8 1/2	8 1/2
7 1/2	8 1/4	8 1/4	8 1/2	8 1/2	8 3/4
7 5/8	8 1/4	8 1/2	8 1/2	8 3/4	8 3/4
7 3/4	8 1/2	8 1/2	8 3/4	8 3/4	9
7 7/8	8 1/2	8 3/4	8 3/4	9	9
8	8 3/4	8 3/4	9	9	9 1/4
8 1/8	8 3/4	9	9	9 1/4	9 1/4
8 1/4	9	9	9 1/4	9 1/4	9 1/2
8 3/8	9	9 1/4	9 1/4	9 1/2	9 1/2
8 1/2	9 1/4	9 1/4	9 1/2	9 1/2	9 3/4
8 5/8	9 1/4	9 1/2	9 1/2	9 3/4	9 3/4
8 3/4	9 1/2	9 1/2	9 3/4	9 3/4	10
8 7/8	9 1/2	9 3/4	9 3/4	10	10
9	9 3/4	9 3/4	10	10	10 1/4
9 1/8	9 3/4	10	10	10 1/4	10 1/4
9 1/4	10	10	10 1/4	10 1/4	10 1/2
9 3/8	10	10 1/4	10 1/4	10 1/2	10 1/2
9 1/2	10 1/4	10 1/4	10 1/2	10 1/2	10 3/4
9 5/8	10 1/4	10 1/2	10 1/2	10 3/4	10 3/4
9 3/4	10 1/2	10 1/2	10 3/4	10 3/4	11
9 7/8	10 1/2	10 3/4	10 3/4	11	11
10	10 3/4	10 3/4	11	11	11 1/4
10 1/8	10 3/4	11	11	11 1/4	11 1/2

LIBRARY
OF THE
UNIVERSITY of ILLINOIS

"Office Standards" is a term given to the set of rules of any office, governing constructional details. However the rules of the different offices are substantially the same, since they conform very nearly to the standards of the rolling mills as to the details of the connections, for it must be remembered that the steel work for buildings is almost universally fitted up in the shops connected with the rolling mill. The mill standards prescribe that a certain size of connecting angle must be used with certain sizes of beams. For example, a 24-inch I beam requires a 4" × 4" × 3/8" angle 1 foot 6 inches long, and 20-inch and 18-inch I's require a 4" × 4" × 3/8" angle 1 foot 3 inches long.

The office standards of the office in question are shown on pages 55 to 62. Pages 55 and

56 show the standard connecting angles, punchings, area of cross section, flange guages, etc., for the different depths of of I beams. Page 57 shows the same for the different depths of channels. Page 58 shows the standard framing of opposite beams flush on bottom; when the beams are flush on the top the distances for the location of the connections are measured from the top flanges instead of from the bottom. Page 59 shows the standard details of cast-iron column connections. Page 60 illustrates the standard beam details; the upper figure of the page gives the standard flange and web punchings, the former for the connections, the latter for separators, beam connections, and for wall anchorage; the second figure shows the way in which the flanges of one beam are

to be cut away to clear the flanges of the beam with which it is connected; and the last two figures on the page shows the method of detailing beams when on a skew, as for example in a roof. Pages 61 and 62 give the standard dimensions of rivets and bolts.

If any connection is made other than standard, it is called a special connection, and all dimensions, including the rivet spacing, must be shown on the drawings, but in case the standard connection is used, the rivet-spacing dimensions need not be given on the drawing. It sometimes happens that a standard connection for beams framing opposite, cannot be used. For example, if an 18-inch I beam, and a 15-inch I beam frame opposite,

either the rivet spacing for the 18-inch I beam connection must be changed to suit the 15-inch I beam, or the spacing of the rivets in the 15-inch I beam must be made to conform with that of the 18-inch I beam. On page 55 of the standards, the rivet spacing for the 18-inch I beam, on the out standing leg, is shown to be 3 inches, while for the 15-inch I beam it is $2\frac{1}{2}$ inches, therefore the connection for one may be made standard but that for the other must be made special. The same rules must be observed in the case of channels framing into beams.

Let it be assumed that a 12-inch I and a 10-inch I frame opposite into a 20-inch I, as shown in Fig. 28, page 67, and that it is required to show the details for the 10-inch I framing opposite the 12-inch I on

the left, and the 10-inch I on the right. Further it will be assumed that all beams are flush on top. Fig. 29 shows the relative **elevation** of the beams as they will be when in place in the finished floor. Since the

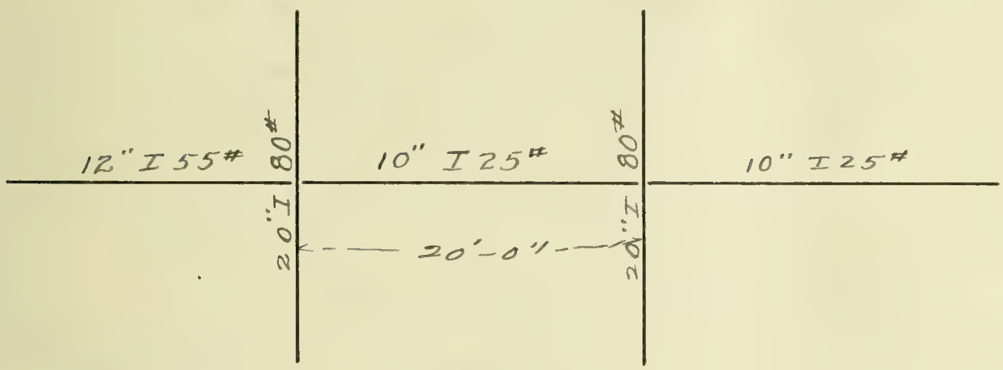


FIG. 28.

Section of Floor Plan.

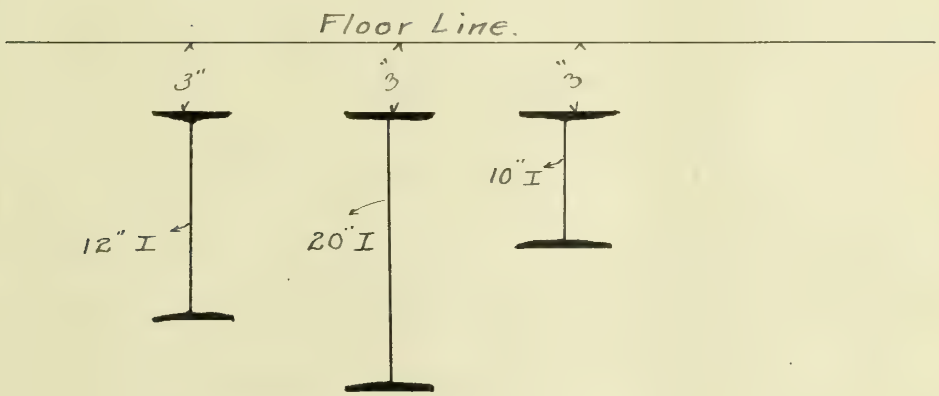


FIG. 29

Relative Position Required.

beams are flush on top, the 10-inch beam must be coped so that the ends of it may fit closely to the webs of the 20-inch beams. The manner of indicating the coping is shown in Fig. 30, which also shows the other details of this beam. The connecting

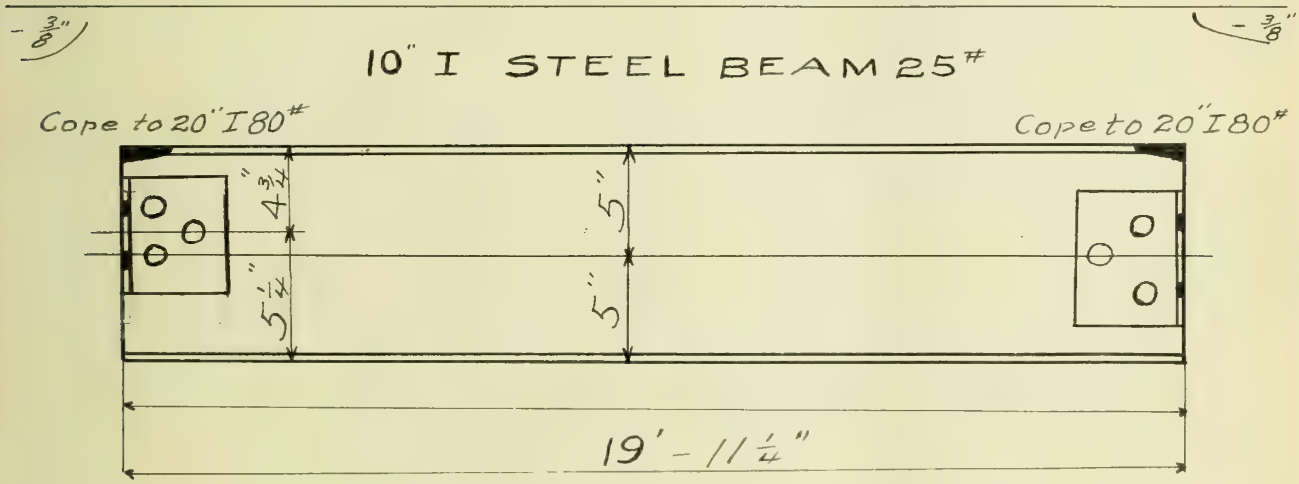


FIG. 30.

angles are standard, and are shown on page 56 under the "Standard Framing" of the 7", 8", 9" and 10" I's. The dimensions locating the centers of the connections are shown in the figure on page 58 under the 12-inch and 10-inch I beams. In this case the beams being flush on the top,

the center of the left connection in Fig. 30 is $4\frac{3}{4}$ inches from the top flange instead of $4\frac{3}{4}$ inches from the bottom flange, as is shown on page 58. To find the required length of the beam, it is necessary to subtract one half the web thickness of the 20" I's plus $\frac{1}{16}$ inch for clearance, from 20 feet - the distance from center to center of the 20" I beams. To get the thickness of the web of the 20-inch 80 pound I beam, look on page 55 in the column of web thickness opposite 20" and under 80 pounds, which gives $\frac{5}{8}$". Then the clearance at the ends is; $\frac{1}{2} \times \frac{5}{8}'' + \frac{1}{16}'' = \frac{3}{8}''$. Therefore the required length for the 10-inch beam is: $20'\ 0'' - (\frac{3}{8}'' + \frac{3}{8}'') = 19'\ 11\frac{1}{4}''$. This length is placed on the bottom line as shown in Fig. 30. As a rule all flange dimensions other than the total length, are given on dimension lines above

the drawing, while all web dimensions are given below the drawing as shown in Fig. 30. In case these beams were flush on the bottom instead of on the top, the drawing would be as shown in Figure 31, below.

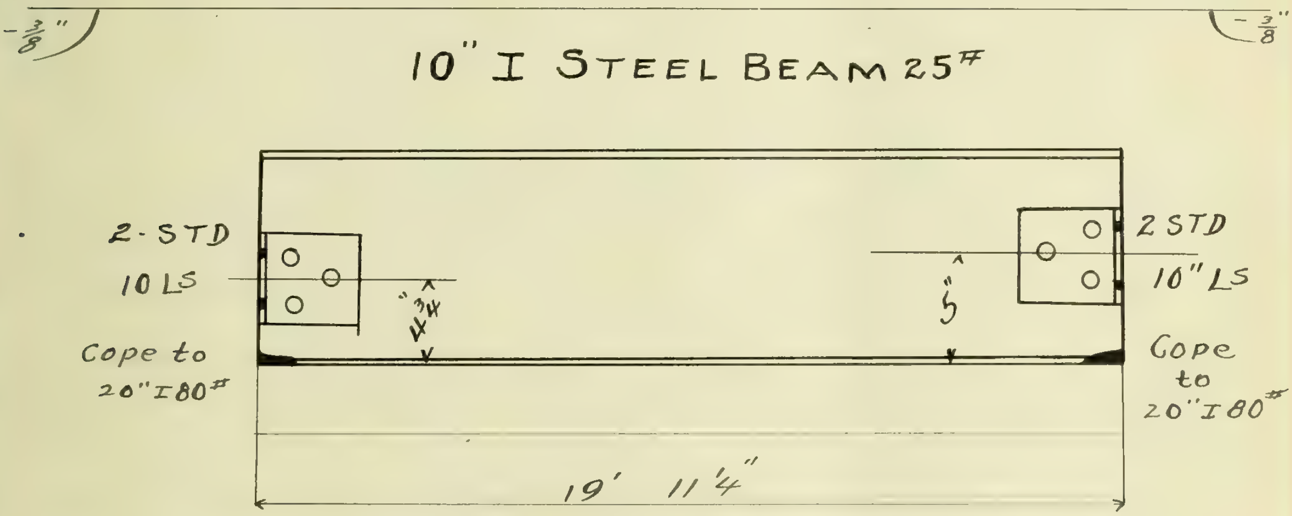


FIG. 31.

If the 20-inch I 80# beam is not flush with the 12-inch and 10-inch Is, the beam above will not be coped. Sometimes it happens that a beam will need to be coped on both ends, and also on top and bottom.

For further illustrations

of beam detailing examples will be taken from the portions of the floor plans of the McNeill building given on pages 72 to 80. These sections are part of an original set of blue prints of the McNeill building used at the office of Purdy and Henderson in detailing the steel for this building.

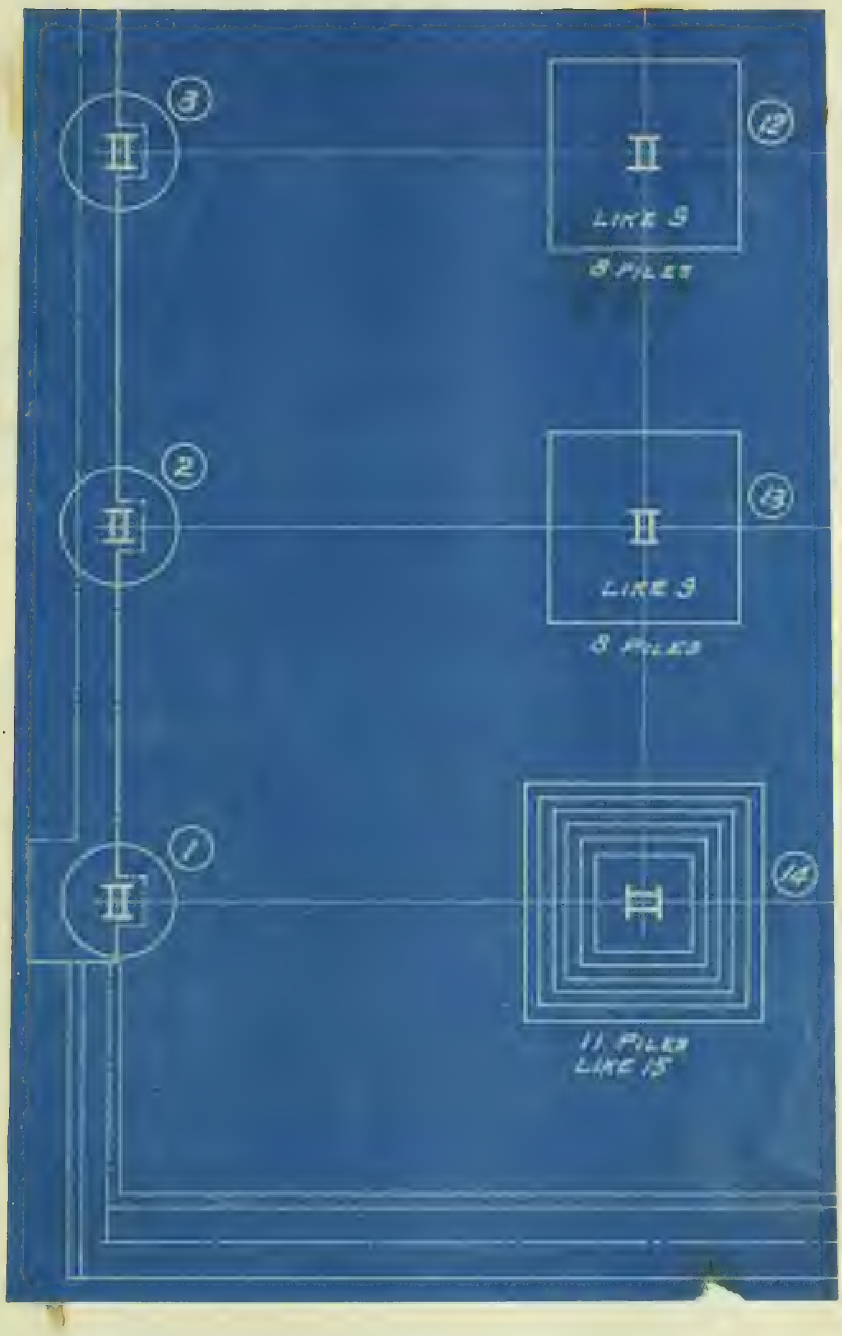
Page 72 gives a portion of the southwest corner of the basement plan, in which are shown the building lines and the position of some of the columns. The foundations under the columns consist of piles driven into the ground and capped with concrete. The numbers in the adjacent circles are the numbers of the columns.

Page 73 shows the foundations of the columns in elevation.

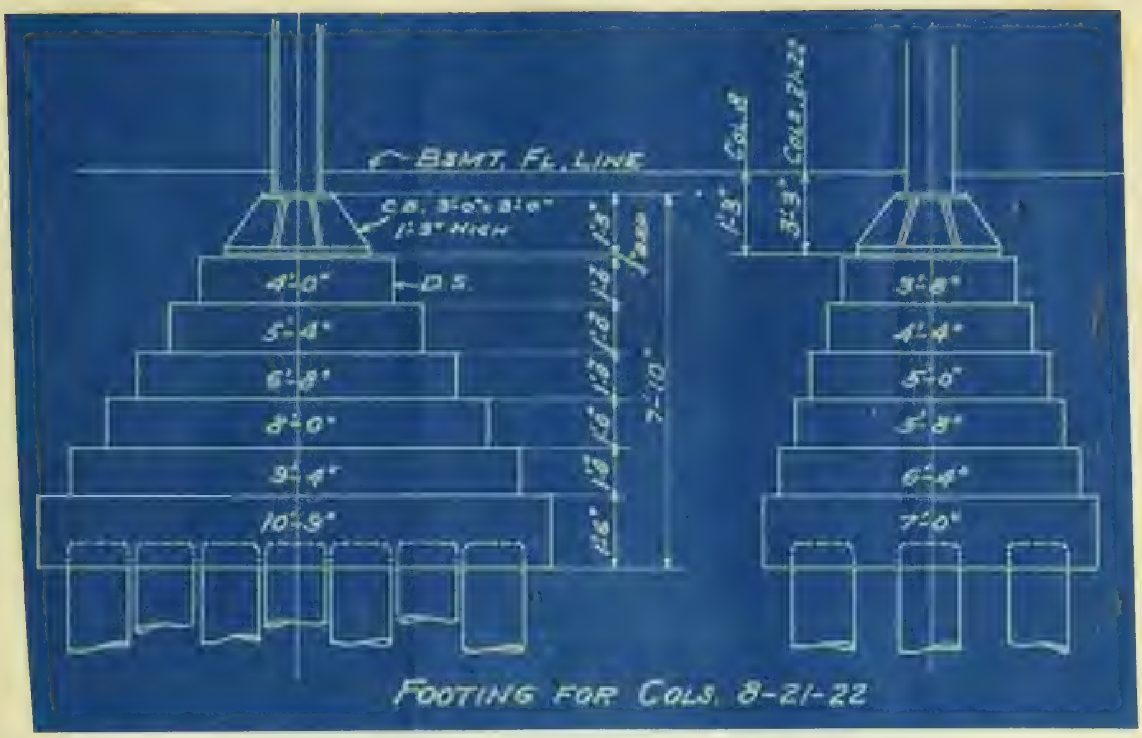
Page 74 shows the first-floor plan, page 75 the second-floor,

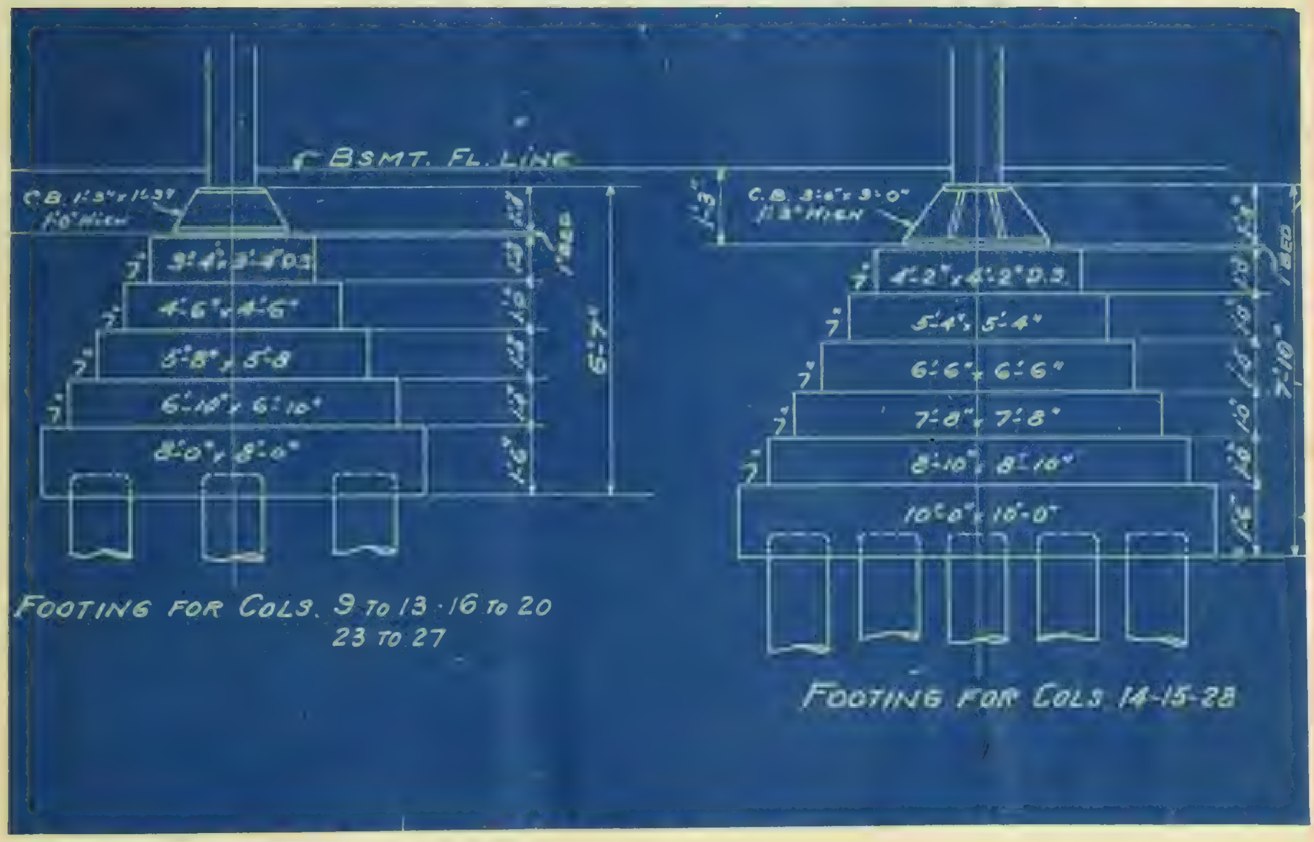
page 76 the third-floor, page 77 the plans for the 4th, 5th, 6th, 7th, and 8th floors, page 78 the ninth-floor, page 79 the tenth-floor, and page 80 the ceiling for the tenth story. Page 81 gives the "sections" of the different columns from the basement to the seventh story. The areas of the cross-sections of the several columns are placed in the upper right hand corner of the square corresponding to the column.

Details of some of the beams of the different floors are given on pages 82 to 87, and the beams detailed as examples are indicated by a check mark thus ✓, on the floor plans pages 74 to 79.

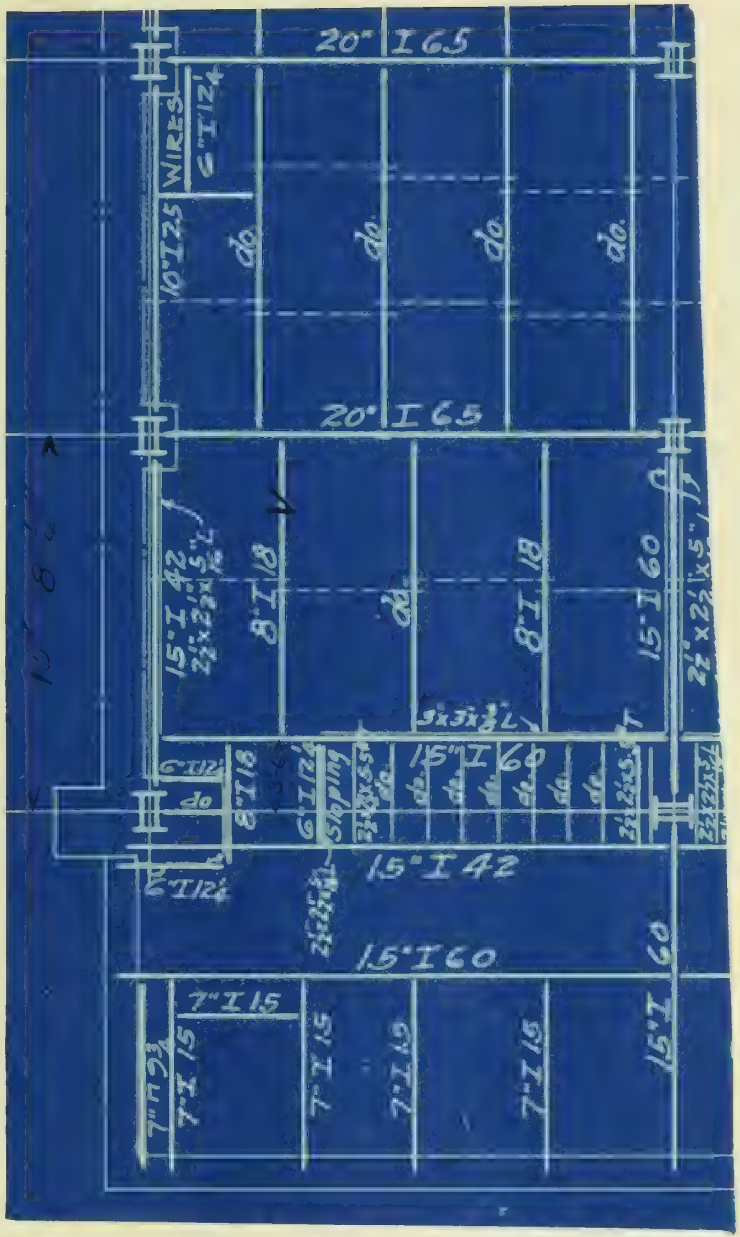


Basement - Plan.

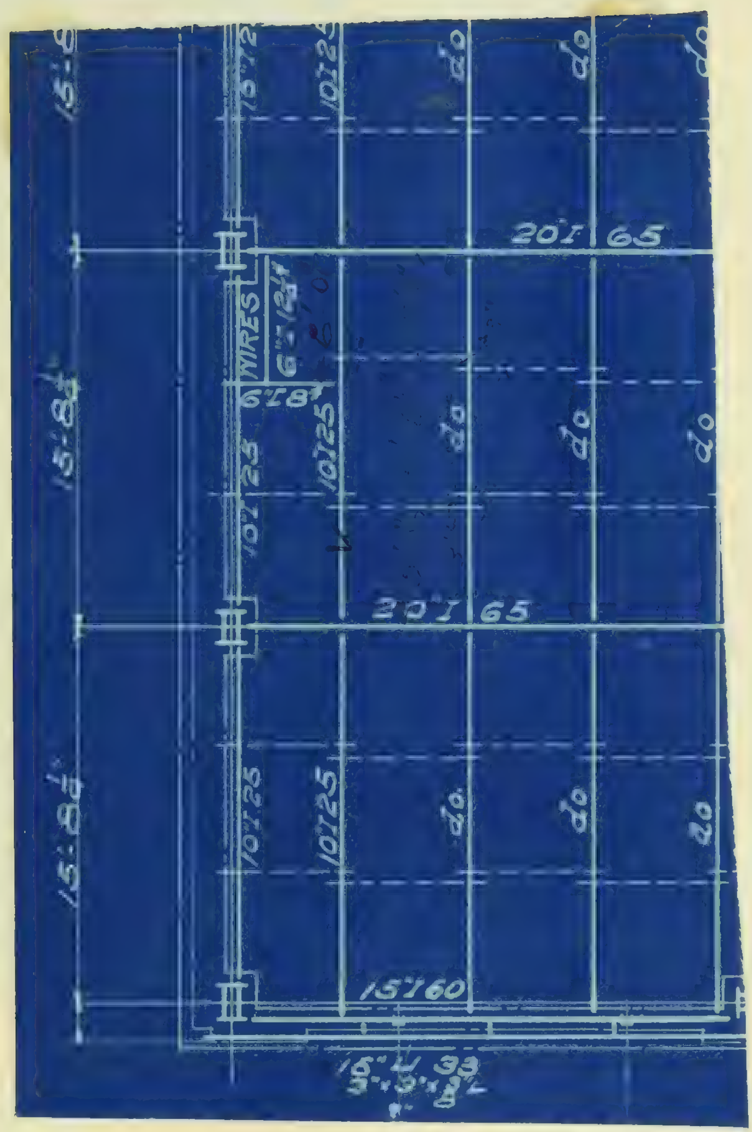




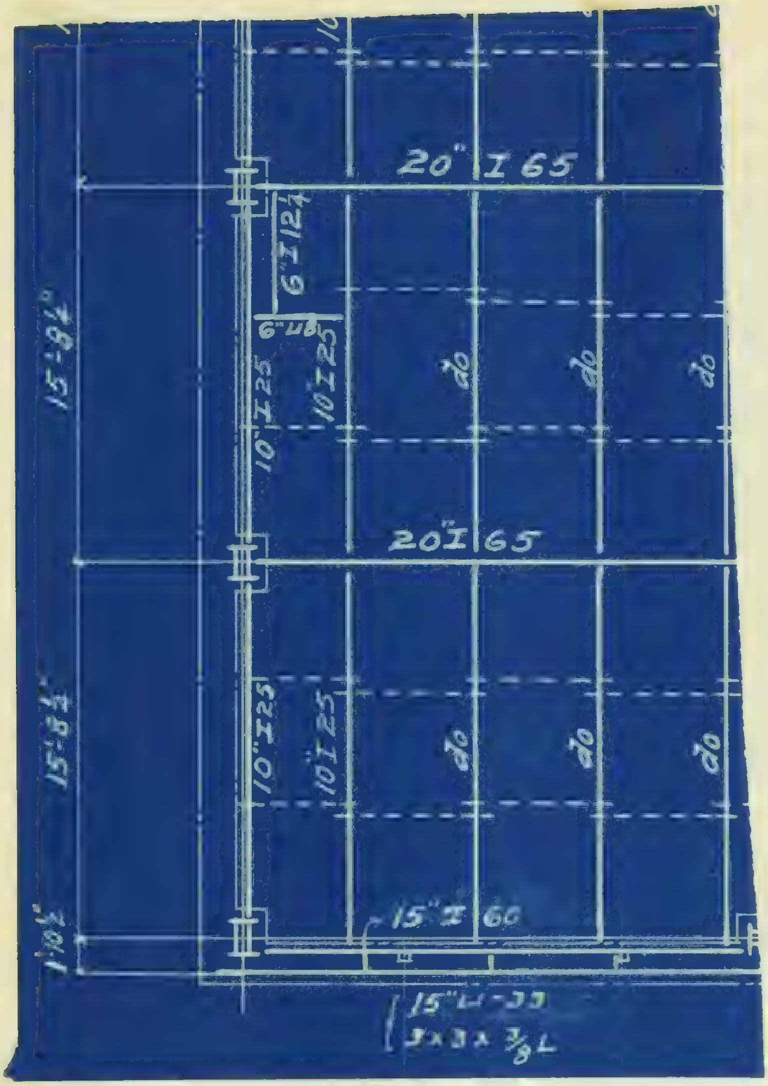
Elevation of Column Foundations



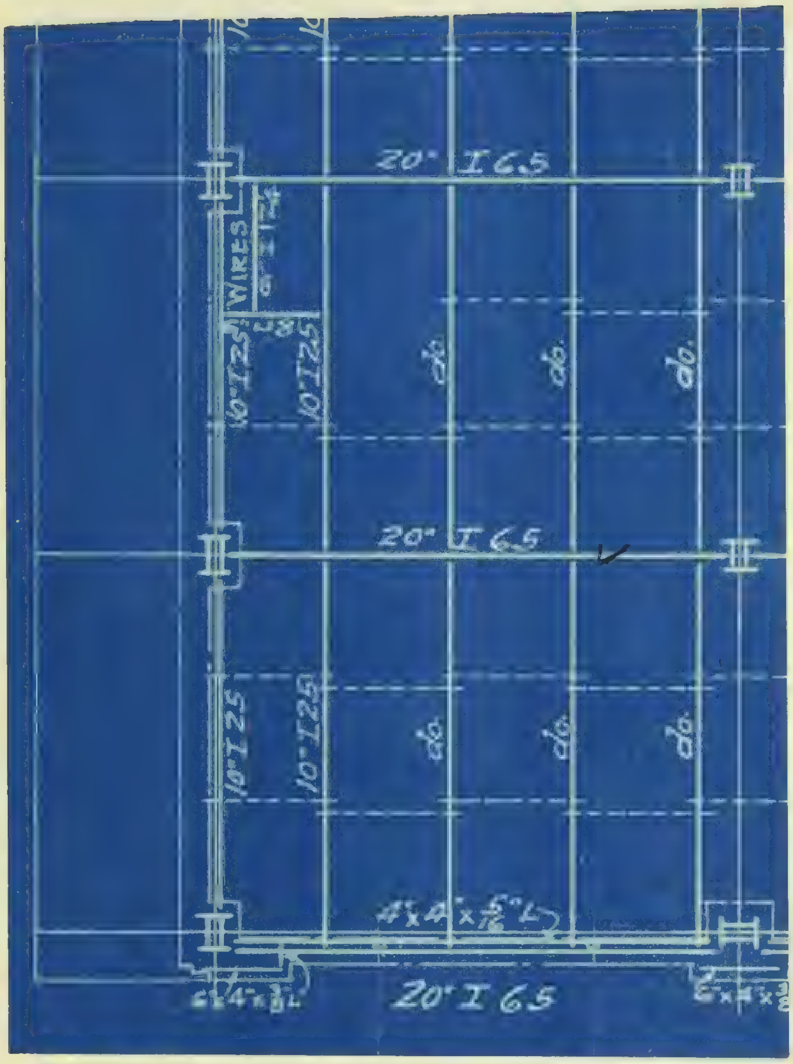
First-Floor Plan.



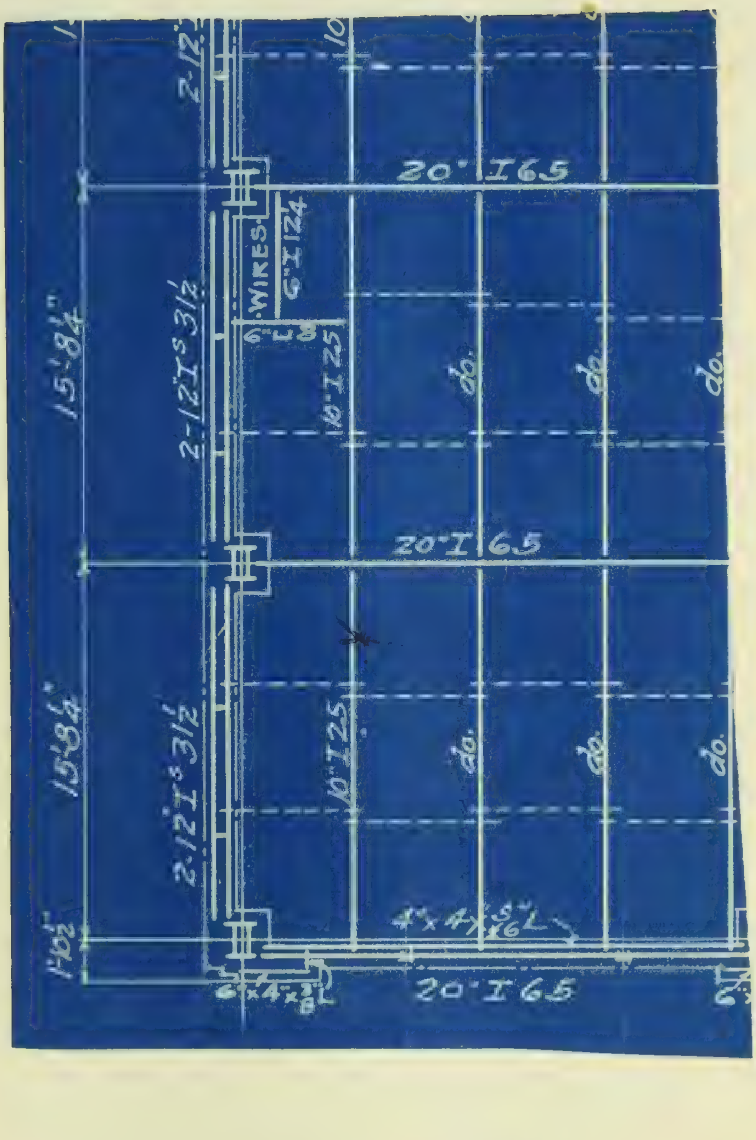
Second-Floor Plan.



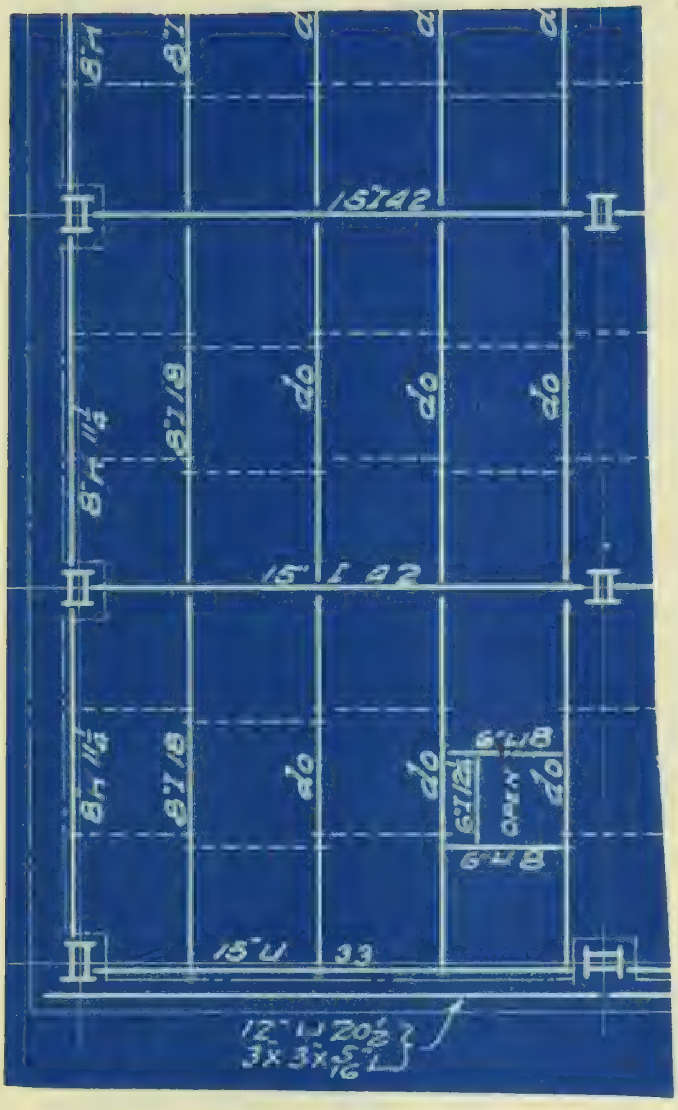
Third - Floor Plan.



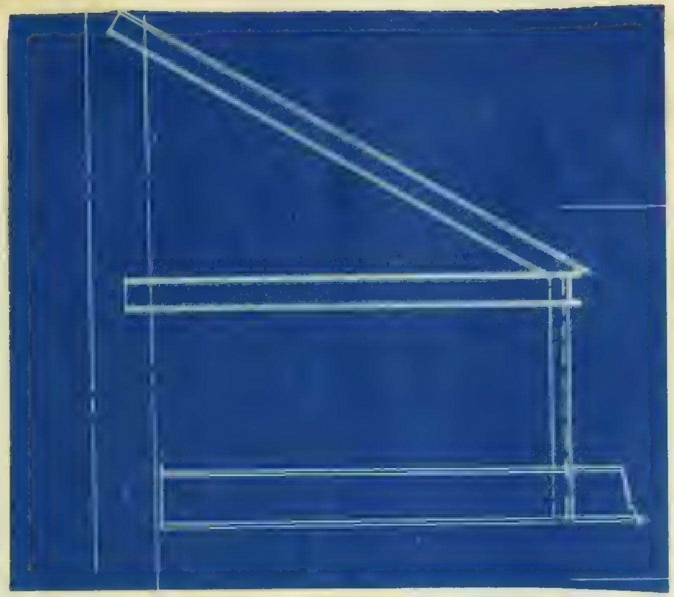
Plan for the 4th, 5th, 6th, 7th, and 8th Floors

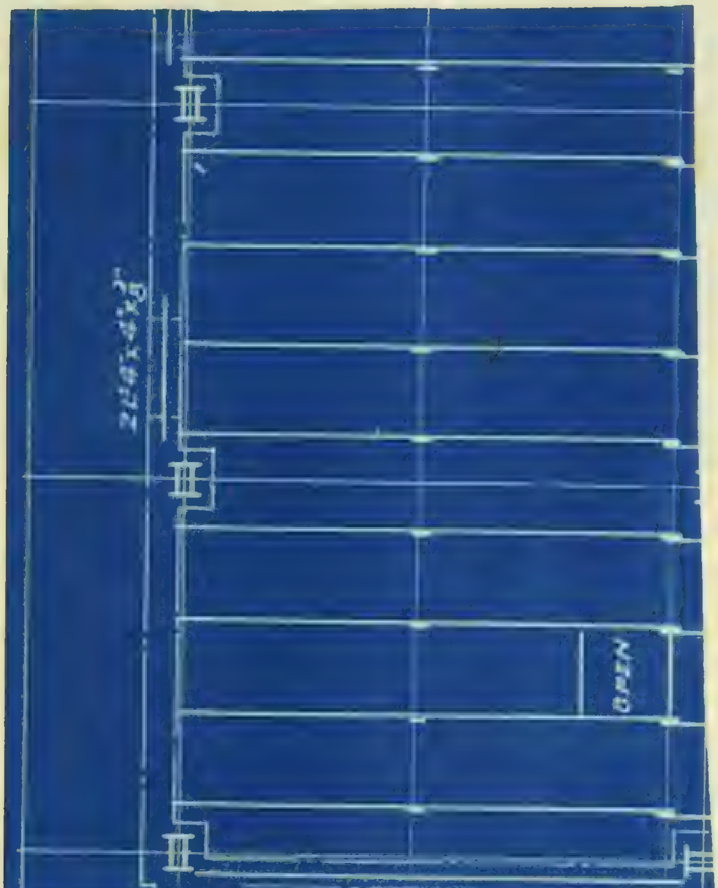


Ninth Floor Plan.



Tenth-Floor Plan.





Ceiling Plan and Roof Elevation

7th 12' 12'-5½" 6th	2 [s 10-25 2 pls 12" x 3/16	2 [s 10-25 2 pls 12 x 5/8"	2 [s 10-25 2 pls 12 x 3/8	2 [s 10-25 2 plates 12" x 5/16	22.2 2 [s 10-25 2 pls 12 x 5/16
12'-5½" 5th 12'-5½" 4th	35.6 2 [s 10-30 2 pls 12" x 3/4"	41.6 2 [s 10-30 4 pls 12" x 1/2"	35.6 2 [s 10-30 2 pls 12 x 3/4	26.6 2 [s 10-30 2 pls 12" x 3/8"	26.6 2 [s 10-30 2 pls 12" x 3/8"
12'-5½" 3rd 15'-5½" 2nd	44.6 2 [s 10-35 4 pls 12" x 1/2"	56.6 2 [s 10-35 4 pls 12 x 3/4"	44.6 2 [s 10-35 4 pls 12" x 1/2"	35.6 2 [s 10-35 2 pls 12" x 5/8"	35.6 2 [s 10-35 2 pls 12" x 5/8"
16'-[illegible] 1st 12'-5½" Basement	53.6 2 [s 10"-35" 4 plates 12" x 1/2"	67.8 2 [s 10"-35" 4 pls 12 x 11/16" 2 pls 9½ x 3/4"	53.6 2 [s 10"-35" 4 pls 12" x 11/16"	41.6 2 [s 10"-35" 4 pls 12" x 7/16"	44.6 2 [s 10-35 4 pls 12 x 1/2"

COLUMN SECTIONS

Column Nos. / Stories	1 29	2 to 6 30 to 34	7 35	8 21 22	9 to 13 16 to 20 23 to 27	14 15 28
Roof and Ceiling	53200	34510	52600	52600	34510	53200
10th	133930	145490	131750	107580	89670	109420
9th	199690	232420	197490	159480	144040	160990
8th	265450	319350	263230	211380	198410	212560
7th	331600	406810	329360	263610	253110	264460
6th	397750	494270	395490	315840	307810	316360
5th	464290	582270	462010	368410	362850	368600
4th	530830	670270	528530	420980	417890	420840
3rd	608630	758820	595450	473890	473270	486080
2nd	676000	850330	664890	528180	528950	536600
1st	740600	954460	734320	578070	586430	577500

COLUMN LOADS

From the floor-plan, page 74, it is seen that the 8-inch 18-pound I frames into a 20-inch 65-pound I on the right, and into a 15-inch 60-pound I on the left. It is assumed that for this floor all beams are flush on the bottom; therefore the beam as shown in detail Fig 32, page 87, must be coped on the bottom as shown. The connecting angles for this beam are standard, and are shown on page 56 of the "Office Standards". On page 55 of the "Office Standards", the web thickness for the 20-inch 65-pound I beam is found to be ½ inch, and that of the 15-inch 60-pound I beam ⅝ of an inch; therefore, the amount of clearance for the right end of the beam in question - shown in Fig 32. - is $\frac{1}{2} \times \frac{1}{2}'' + \frac{1}{16}'' = \frac{5}{16}''$, and that for the left end is $\frac{1}{2} \times \frac{5}{8}'' + \frac{1}{16}'' = \frac{3}{8}''$. The total length of the beam is then 12' 1 9/16".

Fig 33, page 87, gives the details of the 10-inch 25-pound I beam shown in the second-floor plan on page 75. The connecting angles are standard and are of the same dimensions as the 8-inch I connecting angles as shown by the "Office Standards." The small holes in the web of the beam, Fig 33, are for tie-rods, which serve as stiffeners to the whole floor system. They all are placed on one level, and are invariably 3 inches apart, as shown in Fig. 33. The two center holes in the web are for the connection of the channel which frames into this beam, as shown by the second-floor plan page 75.

Two tie-rod holes were provided on the right so that in case the tie-rods were not placed in the order indicated on the

second-floor plan, it would not necessitate the changing of those already in [illegible]. The length of the beam in Fig. 33 was found in the manner explained under the beam in Fig 32., and presents no new features in this case.

The beam shown in detail by Fig 34 is taken from the floor plan shown on page 77. This beam serves as a girder, and connects with a column on each end. The dimensions were not given on the floor plan, so the detail in Fig 34, is without dimensions except as shown. The dimensions shown are standard for the 20 inch beams, and is taken from the office standards on page 59. The clearance for column connections is $\frac{1}{4}$ inch. The other holes shown in the web Fig. 34 are for the beam connections framing into

the 20-inch "girder beam" as shown in plan on page 77.

Fig. 35, page 88, gives the details for the 10-inch 25-pound I beam located in the ninth-floor plan, page 78. The only new feature presented in this figure is the dimensions for flange punching. The flange connections for this beam are merely two stay bolts anchoring the beam and the angle upon which this beam rests, to the wall, as shown on page 78.

Fig. 36 shows the details for the 6 inch 8-pound channel located in the tenth-floor plan, page 79. No new features present themselves in detailing channels that have not already been described under beam details; therefore Fig. 36 needs no explanation.

The writer believes that further details would merely be a repitition of what has

already been shown or described either by drawings or by the use of the "Office Standards"; therefore no more space will be devoted to the subject of making detail drawings.

1ST FLOOR _ McNeill Building

−3/8" −5/16"

8" STEEL I BEAM 18#

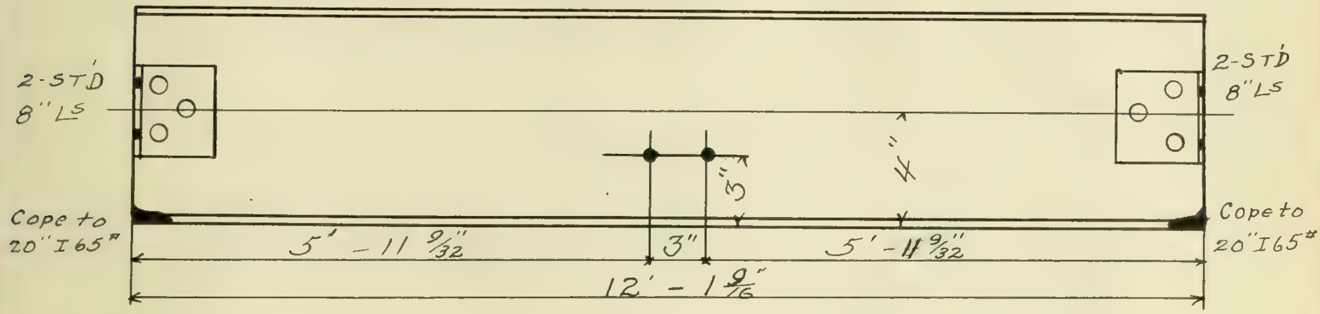


FIG. 32.

−5/16" −5/16"

10" STEEL I BEAM 25#

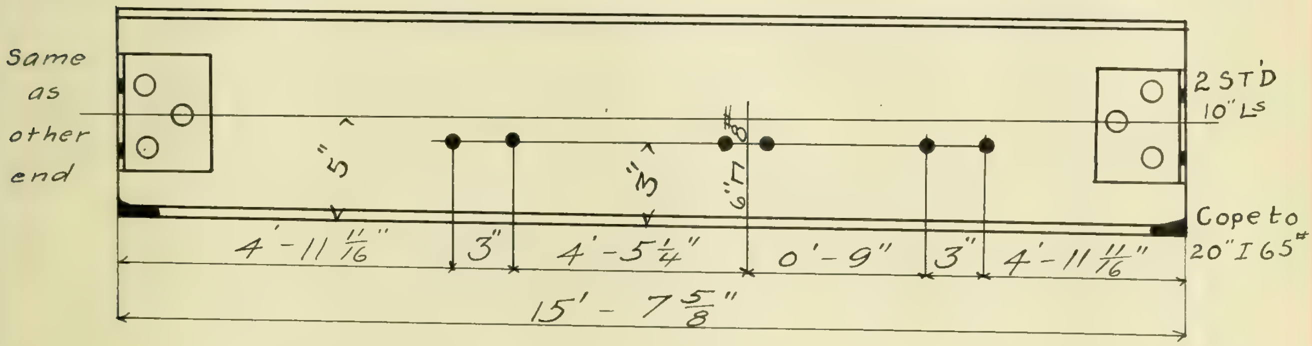


FIG. 33.

−1/4" −1/4"

20" STEEL I BEAM 65#

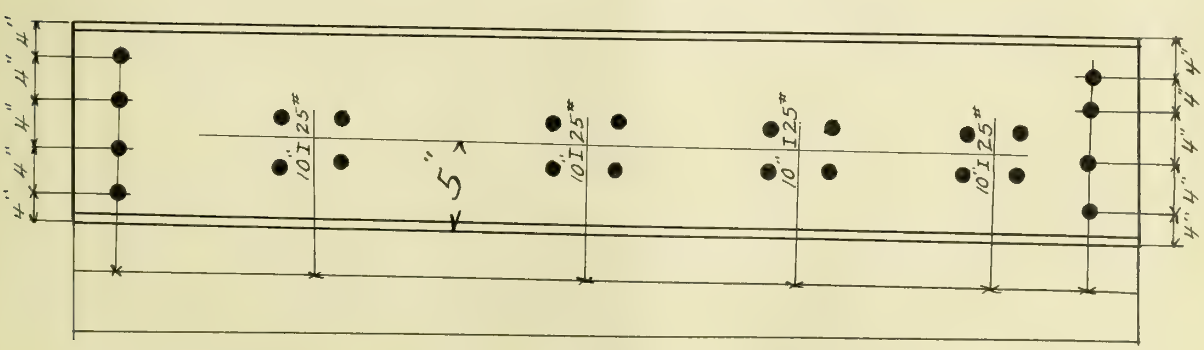


FIG. 34.

9TH FLOOR McNeill Building.

10" STEEL I BEAM 25#

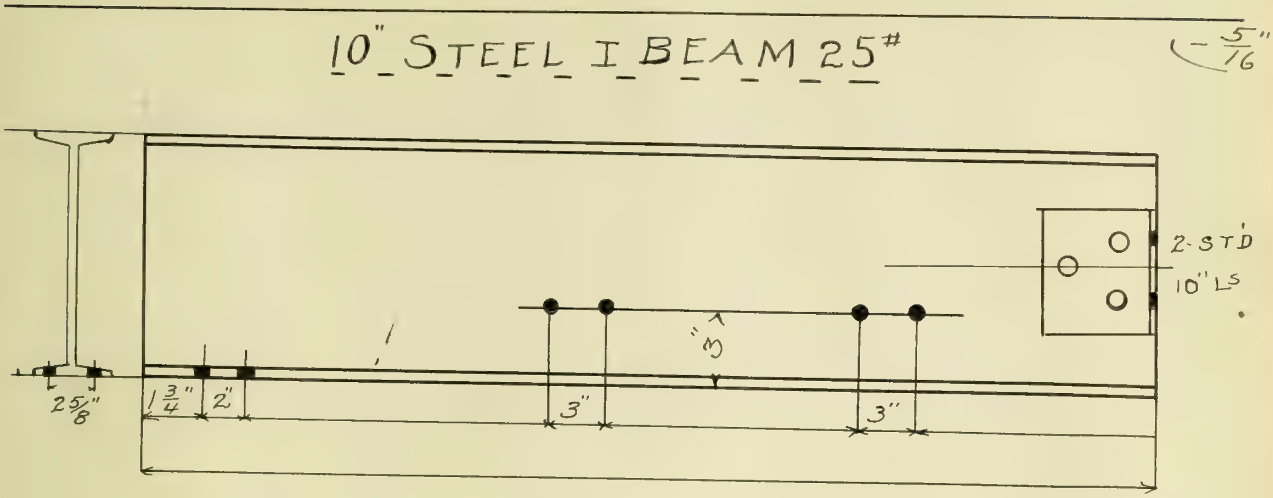


FIG. 35.

6" STEEL CHANNEL 8#

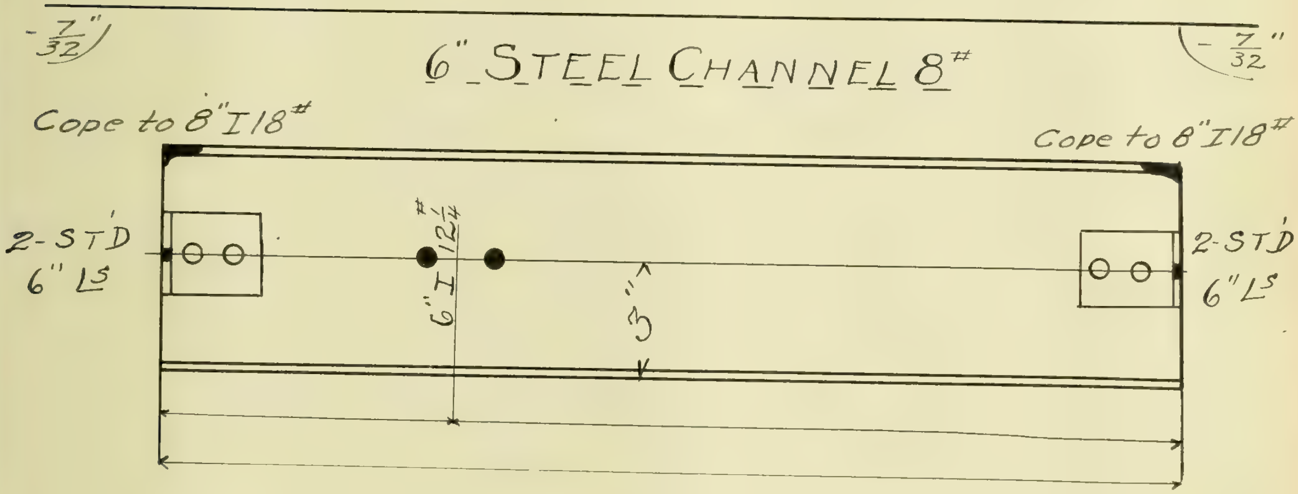


FIG. 36.

10. ESTIMATE OF THE WEIGHT OF THE MATERIAL:- In estimating the weight of the material in a building it is the custom of the office in question to make use of forms, such as the one given on the following page. In the first column the numbers of the beams, channels, angles, etc., are placed; in the second column are placed the page numbers of the beams, channels, etc., described on page 43; in the third column the invoice mark- some number or letter stamped upon the material at the mill- is placed; in the fourth column the description of the material is placed. This description consists in stating whether it is channels, beams, Ts, angles, or plates etc., with the weight per linear foot. The letters F_1, P_2, P_1, in the column headed SHOP-WORK, indicate the kind of shop work done upon the material, i.e., F is for beams fitted- having connecting

FLOOR

BEAM NO.	PAGE	INV. MARK	DESCRIPTION OF PIECE	SHOP WORK	LENGTH OF PIECE	CALCULATED WEIGHT Is AND Es	CALCULATED WEIGHT OTHER SHAPES	INVOICED WEIGHT	WT. OF FITTINGS CALCULATED	WT. OF FITTINGS INVOICED
50	165		7 ⊏ 9 3/4	F	2'-8 1/2					
51	"		7 I 15	"	5'-9 3/4					
52	"		8 I 18	"	15'-1 1/2					
53	"		"		"					
54	"		"	"	"					
55	"		"	"	"					
56	"		"	"	"					
57	"		"		"					
58	"		"		"					
59	"		"		"					
60	"		"		"					
9	166		"	"	16'-1 1/4					
10	"		"	"	16'-0 1/4					
11	"		"	"	16'-0 1/2					
12	"		"	"	15'-8 [illegible]					
2[illegible]	167		[illegible]	F	3'-0 1/2					
193	"		"	"	3'-0 1/2					
150	"		"	"	3'-0 1/2					
164	"		"	"	3'-0 1/2					
178	"			"	3'-0 1/2					
120	"		"	"	3'-0 3/4					
135	"		"	"	"					
231	"		"	"	"					
237	"		"	"	"					
5	168		8 I 18	F	16'-2 3/4					
6	"		"	"	16'-2 1/4					
7	"		"	"	16'-2					
8	"		"	"	16'-1 1/2					
1	164		8 ⊏ 11 1/4	"	16'-[illegible]					
2	"		8 I 18	"	16'-3 3/4					
3	"		"	"	16'-3 1/2					
4	"		"	"	16'-3					
61	170		"	"	4'-9 1/2					
17	"		7 ⊏ 9 3/4	"	14'-0 9/16					
18			7 I 15	"	"					
20			"	p "	"					
[illegible]			"	"	"					
[illegible]	"		"	"	"					
[illegible]	"		"	"	"					
[illegible]			"	"	"					
[illegible]	"		"	"	"					
[illegible]	"		"	"	"					
[illegible]	"		"	"	"					
35	"		8 I 18	"	"					

LIBRARY
OF THE
UNIVERSITY of ILLINOIS

angles riveted to the ends; P_2 means that the members have flange-punchings, and P_1 web punchings. The lengths of the different pieces are given in the sixth column, usually in feet and inches. However it would be much more convenient to have the length given in feet and decimals of a foot, when it comes to figuring the weight; but since the length of the material is given for the use of the men at the mill, it is more convenient for them that the lengths be given in feet and inches. The calculated weight in column seven is the weight figured at the drafting office by multiplying the weight per foot by the total length in feet; while the invoiced weight is the actual scale weight at the shop. The two serve as a check on each other.

"When a contractor buys structural steel for a building at a stated price per pound, usually varying according to a certain

classification, a part of the material such as riveted columns, trusses, girders and the like, is invoiced at scale weight; while beams, channels, angles, tees, etc., are usually invoiced at calculated weight.

"The only way the purchaser has for checking the invoices is to calculate the weights. Obviously no variation can be allowed except on material which is invoiced by scale weight. Here the variation from calculated weight must not exceed 2½%, for under the "Manufacturers' Standard Specification", a variation of 2½% will be sufficient cause for rejecting the material. The actual variation between scale and calculated weights of all the columns, etc., for a large building is almost nil. Some will vary slightly one way and some the other. Owing to pin holes, corners cut off, etc., the chances are favorable for the calculated weight to exceed the scale weight by a small amount. The foregoing state-

ments on the invoicing of the weight of the material are based on the practice of Carnegie Steel Co's large shops, and it is believed the practice is generally followed,– there is one firm however,– the Brown–Ketcham Iron Works of Indianapolis, Indiana, that invoices all material at calculated weights.

The method of figuring weights for steel-frame buildings does not differ materially from that employed in figuring the weight of bridges, hence the writer thinks it is not necessary to devote more space to this part of the subject.

A few words on the cost of making detailed drawings may be in place in concluding this thesis. The subject of costs is a very difficult one to handle, for the reason that costs are always relative and what may be a fair cost in one case may not be in

another. The cost per ton for making details of the steel in steel-frame buildings varies with the character of the work and the tonnage that is to be fabricated of one form, so the cost per ton may mean very little. Details for church and court-house roofs having hips and valleys cost from $5.00 to $8,00 per ton; details for ordinary steel-frame office buildings cost from $2.00 to $4.00 per ton. The cost including shop work varies from $15.00 to $25,00 per ton, in some cases even more.

It is often possible to reduce the cost of a job by shipping the connections separate from the beams and riveting them on in the field rather than to have them put on at the shop connected with the rolling mill.

Finis.

UNIVERSITY OF ILLINOIS-URBANA
3 0112 086824098